

J.P. Morgan Semiconductor and Semiconductor Capital Equipment

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J.P. Morgan Semiconductor Universe Comp Sheet

JPM Rating	Market Cap	3/26/21 Price	Non-GAAP EPS		P/E		Revenue		P/S		EV/Sales		Consensus Non-GAAP EPS		Consensus Sales		Consensus P/E		Consensus P/S				
			C21E	C22E	C21E	C22E	C21E	C22E	C21E	C22E	C21E	C22E	C21E	C22E	C21E	C22E	C21E	C22E	C21E	C22E			
Harlan Sur, Lead Coverage																							
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PC Semiconductors																							
INTC	OW	\$255,460	\$62.02	\$4.58	\$4.94	13.6	12.5	\$72,200	\$74,250	3.5	3.4	3.6	3.5	\$4.58	\$4.70	\$72,951	\$72,851	13.6	13.2	3.5	3.5		
NVDA	OW	\$316,390	\$501.41	\$14.14	\$17.90	35.5	28.0	\$23,086	\$27,582	13.7	11.5	13.3	11.1	\$13.00	\$14.35	\$21,776	\$24,073	38.6	34.9	14.5	13.1		
AMD	N	\$93,446	\$76.22	\$1.93	\$2.32	39.5	32.9	\$13,371	\$15,257	7.0	6.1	6.8	5.9	\$1.91	\$2.45	\$13,482	\$15,546	40.0	31.1	6.9	6.0		
Memory																							
MU	OW	\$95,442	\$84.09	\$6.30	\$10.24	13.4	8.2	\$28,995	\$36,124	3.3	2.6	3.2	2.6	\$6.62	\$10.63	\$29,175	\$35,646	12.7	7.9	3.3	2.7		
WDC	N	\$19,663	\$64.05	\$5.02	\$9.15	12.8	7.0	\$12,302	\$13,013	1.6	1.5	2.1	2.0	\$5.02	\$8.09	\$17,647	\$19,596	12.8	7.9	1.1	1.0		
Enterprise/Networking/Datacenter Semiconductors																							
XLNX	N	\$29,785	\$120.03	\$3.34	N/A	35.9	N/A	\$3,427	N/A	8.7	N/A	8.2	N/A	\$3.39	\$3.90	\$3,401	\$3,693	35.4	30.8	8.8	8.1		
MRVL	NR	\$30,786	\$44.75	\$1.44	N/A	31.2	N/A	\$3,583	N/A	8.6	N/A	8.6	N/A	\$1.34	\$1.73	\$3,442	\$3,938	33.5	25.8	8.9	7.8		
AVGO	OW	\$197,608	\$461.70	\$27.76	\$30.98	16.6	14.9	\$27,095	\$29,234	7.3	6.8	8.3	7.7	\$27.15	\$29.29	\$27,030	\$28,399	17.0	15.8	7.3	7.0		
IPHI	NR	\$8,841	\$168.00	\$3.85	N/A	43.7	N/A	\$800	N/A	11.0	N/A	11.7	N/A	\$3.78	\$4.38	\$802	\$925	44.5	38.4	11.0	9.6		
Mobile Devices																							
SWKS	N	\$28,746	\$172.13	\$9.57	\$10.44	18.0	16.5	\$4,675	\$4,950	6.1	5.8	5.9	5.6	\$9.76	\$11.10	\$4,768	\$5,248	17.6	15.5	6.0	5.5		
QRVO	OW	\$19,929	\$172.26	\$10.48	\$11.65	16.4	14.8	\$4,415	\$4,825	4.5	4.1	4.5	4.2	\$10.33	\$11.12	\$4,364	\$4,590	16.7	15.5	4.6	4.3		
KN	UW	\$1,897	\$20.41	\$1.25	\$1.40	16.3	14.6	\$862	\$919	2.2	2.1	2.3	2.1	\$1.27	\$1.44	\$861	\$919	16.0	14.1	2.2	2.1		
Analog/Microcontrollers																							
TXN	OW	\$166,353	\$178.49	\$6.84	\$7.58	26.1	23.5	\$16,741	\$17,912	9.9	9.3	9.9	9.2	\$6.93	\$7.49	\$16,639	\$17,405	25.8	23.8	10.0	9.6		
ADI	NR	\$55,929	\$149.90	\$6.04	\$6.78	24.8	22.1	\$6,552	\$6,985	8.5	8.0	9.1	8.5	\$6.10	\$6.77	\$6,577	\$7,013	24.6	22.1	8.5	8.0		
NXPI	N	\$54,573	\$191.31	\$9.75	\$10.50	19.6	18.2	\$10,679	\$11,187	5.1	4.9	5.5	5.2	\$9.29	\$10.33	\$10,429	\$10,987	20.6	18.5	5.2	5.0		
MCHP	OW	\$40,528	\$147.16	\$7.40	\$8.04	19.9	18.3	\$6,109	\$6,494	6.6	6.2	8.0	7.5	\$7.32	\$7.97	\$6,035	\$6,380	20.1	18.5	6.7	6.4		
MXIM	NR	\$23,943	\$88.42	\$3.18	\$3.62	27.8	24.4	\$2,621	\$2,835	9.1	8.4	8.8	8.1	\$3.10	\$3.40	\$2,633	\$2,806	28.5	26.0	9.1	8.5		
SLAB	OW	\$6,127	\$136.98	\$3.44	\$3.76	39.8	36.5	\$1,009	\$1,102	6.1	5.6	5.7	5.3	\$3.42	\$3.88	\$1,005	\$1,090	40.0	35.3	6.1	5.6		
Diversified/Consumer/Standard Components/Other																							
ON	N	\$16,483	\$38.19	\$1.60	\$1.96	23.9	19.5	\$5,941	\$6,101	2.8	2.7	3.1	3.0	\$1.61	\$1.99	\$5,972	\$6,229	23.7	19.2	2.8	2.6		
MTSI	N	\$3,653	\$53.91	\$2.11	\$2.44	25.6	22.1	\$617	\$682	5.9	5.4	6.5	5.9	\$1.97	\$2.29	\$618	\$676	27.4	23.5	5.9	5.4		
MXL	N	\$2,392	\$32.18	\$2.15	\$2.22	15.0	14.5	\$837	\$883	2.9	2.7	3.2	3.0	\$1.93	\$2.15	\$808	\$846	16.7	15.0	3.0	2.8		
SYNA	OW	\$6,127	\$128.10	\$7.69	\$9.21	16.7	13.9	\$1,363	\$1,525	3.4	3.1	3.5	3.1	\$8.05	\$9.04	\$1,368	\$1,475	15.9	14.2	4.5	4.2		
VSH	N	\$3,426	\$23.59	\$1.85	\$2.23	12.8	10.6	\$2,979	\$3,127	1.2	1.1	1.1	1.0	\$1.60	\$1.80	\$2,923	\$3,000	14.7	13.1	1.2	1.1		
Semiconductor Capital Equipment																							
AMAT	OW	\$110,741	\$119.72	\$6.14	\$6.65	19.5	18.0	\$22,055	\$23,040	5.0	4.8	4.9	4.7	\$6.10	\$6.59	\$21,924	\$23,446	19.6	18.2	5.1	4.7		
LRCX	OW	\$79,963	\$548.03	\$25.51	\$30.18	21.5	18.2	\$14,450	\$15,750	5.5	5.1	5.4	5.0	\$26.03	\$29.17	\$14,440	\$15,349	21.1	18.8	5.5	5.2		
KLAC	OW	\$46,576	\$299.41	\$14.36	\$15.27	20.9	19.6	\$6,985	\$7,155	6.7	6.5	6.8	6.6	\$14.22	\$15.36	\$6,984	\$7,388	21.1	19.5	6.7	6.3		
Large Cap Semi Average						25.7	21.1													22.6	20.5	8.0	7.5
Small-Mid Cap Semi Average						23.3	18.3													24.0	20.9	4.6	4.2
Semi Group Average (ex-outliers)						22.4	17.4													22.9	20.2	6.1	5.6
SOX Index			2,960	130	149	22.7	19.9													22.7	19.9	6.3	5.9
S&P500			3,910	173	199	22.6	19.6													22.6	19.6	2.7	2.5

Source: Company reports, Bloomberg Finance L.P., J.P. Morgan estimates.

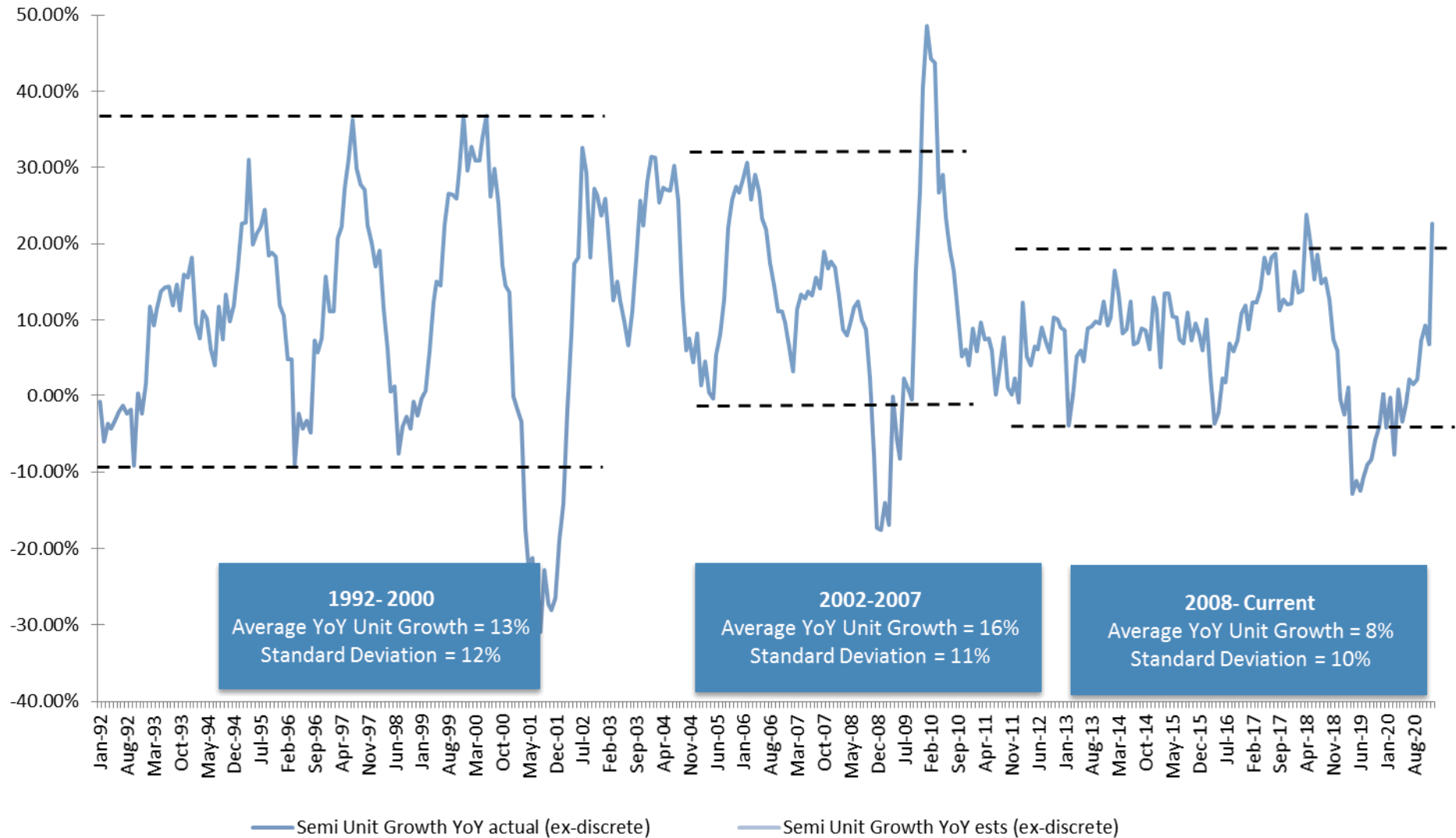
Note: Pricing as of 03/25/2021 close.

Semi/Semicaps – Growth and Cyclical Trends Remain Positive Entering 2021 and Beyond...Our Top Picks Are Broadcom (AVGO) and KLA (KLAC)

- **We believe the semiconductor industry has entered a more stable and less cyclical growth phase characterized by low- to mid-single-digit annual revenue growth and high-single-digit unit growth**
 - With the industry generally driving high-single-digit Y/Y unit growth, the entire value chain is able to better predict silicon consumption requirements, better respond to perturbations in supply/demand, and more efficiently plan manufacturing output
 - As a result, volatility in semiconductor supply/demand and semiconductor equipment spending has muted significantly
 - Compare this to 15-20 years ago, when unit growth rates were +15% Y/Y – small perturbations in supply/demand would drive significant swings in inventory, shipments, capacity planning, and equipment spending
 - **Bottom line:** The current environment is likely more stable and less cyclical for semiconductor and semiconductor capital equipment suppliers. In a maturing industry, we believe the market will focus on market leadership/scale, operating margin and free cash flow margin expansion, and increasing payout ratios
- **We see semi industry revenue up 10-12% Y/Y (bias upward) in 2021 following a 7% Y/Y growth in 2020. Recall 2H20 demand picked up significantly and growth turned positive after 1H20's weak demand environment and supply chain disruptions (COVID-19). In Semiconductor equipment, we see spending up ~16% Y/Y in 2021 led by DRAM and Foundry strength**
- **Supply constraints across all end markets...we see multiple quarters of strength for the semi suppliers.** Channel/customer inventories are at/near historic lows, and lead times are continuing to get stretched out. Given the strong demand environment, combined with supply tightness, we anticipate strong demand trends through 2021
- **Expect continued industry consolidation (M&A):** Focus on scale, diversification, and margin and FCF expansion.
- **Promising outlook for foundry/ memory in 2021 demand and capex spending driving strong semi equipment fundamentals**
- **Govt incentives for US domestic manufacturing capability a positive - innovation and assurance of supply base**
- **Semis large-cap top pick: AVGO; we also favor TXN, INTC, NVDA, MCHP, MU & QRVO**
 - Given continued volatility and potential trade concerns – we focus on market leadership, strong US-based exposure to cloud/5G infrastructure spending trends, strong product cycles, diversification, and margin/free cash flow expansion with increasing payout ratios.
- **Memory capex discipline should drive improved profitability in 2021. Semi capital equipment fundamentals to follow: top pick KLAC (OW).** KLA's top-line performance is outperforming relative to industry peers on strong product cycles and robust Foundry/Logic spending. KLAC dominates the semiconductor process control equipment market with ~5x more market share than their #2 competitor. We are also OW LRCX & AMAT.

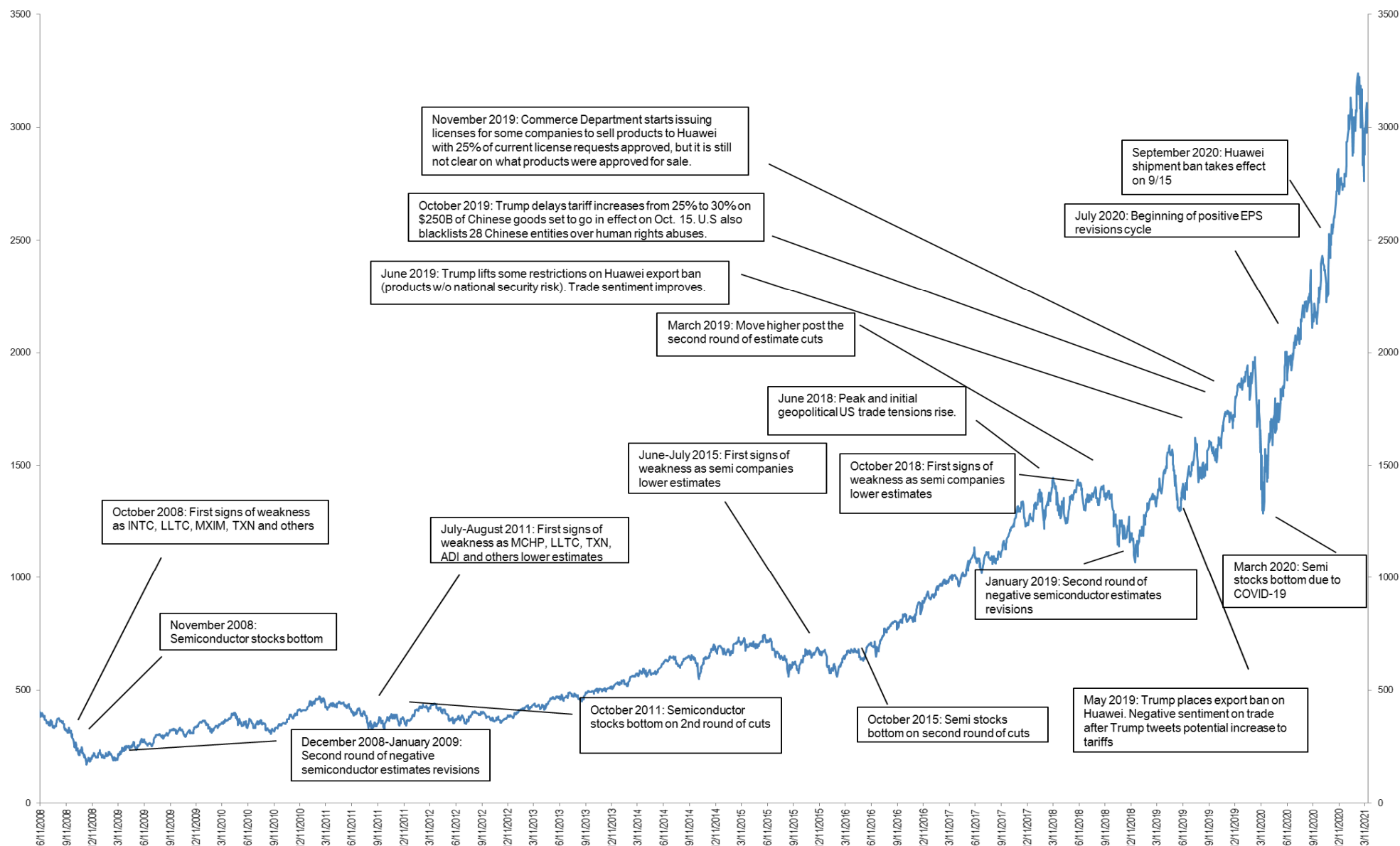
Semis in More Stable Growth Phase – Focus on Market Leadership, Strong Product Cycles, Margin/Free Cash Flow Expansion, and Capital Allocation

Semi Unit Growth YoY (ex-discrete)



Source: WSTS, J.P. Morgan estimates.

Continue to Expect Strong Recovery And See Stocks Continuing To Outperform in 2021

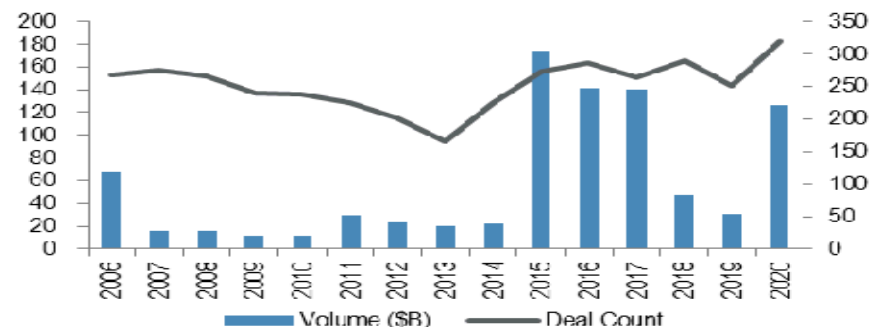


Industry Consolidation Should Help Support Valuations...Expect More M&A

Announcement	Buyer	Target	Deal Value (\$M)	Status	Sector	Expected Completion	China Buyer?
2/8/2021	Renesas	Dialog Semiconductor	5900	Pending	Semi	End of 2021	No
1/13/2021	Qualcomm	NUVIA	1,400	Pending	Semi		No
10/28/2020	Marvel Technology Group Ltd	Inphi	8,200	Pending	Semi	April 2021	No
10/27/2020	Advanced Micro Devices	Xilinx	35,000	Pending	Semi	End of 2021	No
10/19/2020	SK-Hynix	Intel (NAND)	9,000	Pending	Semi	End of 2021	No
9/13/2020	NVIDIA Corp.	ARM Ltd.	40,000	Pending	Semi	1H2022	No
7/13/2020	Analog Devices	Maxim Integrated	21,300	Pending	Semi	Summer 2021	No
7/7/2020	Synaptics Inc.	Broadcom's Wireless IoT Connectivity Business	250	Completed	Semi		No
4/6/2020	MaxLinear	Intel's Connected Home Business	150	Completed	Semi		No
2/20/2020	Dialog Semiconductor	Adesto Technologies	358	Completed	Semi		No
12/16/2019	Intel	Habana Labs	2,000	Completed	Semi		No
8/8/2019	Broadcom	Symantec's Enterprise Security Business	10,700	Completed	Semi		No
7/9/2019	Cisco Systems	Acacia Communications Inc.	2,600	Pending	Semi	2H2020	No
7/1/2019	Applied Materials	Kokusai Electric	2,200	Pending	Semicap	12/30/2020	No
6/24/2019	Nanometrics Inc.	Rudolph Technologies	N/A	Completed	Semicap		No
6/10/2019	Intel	Barefoot Networks	N/A	Completed	Semi		No
6/3/2019	Infineon Technologies	Cypress	10,000	Completed	Semi		No
5/29/2019	NXP Semiconductors	Marvell's Connectivity Business	1,760	Completed	Semi		No
5/20/2019	Marvel Technology Group Ltd	Avera Semiconductor LLC	650	Completed	Semi		No
5/6/2019	Marvel Technology Group Ltd	Aquantia Corp	452	Completed	Semi		No
4/10/2019	Qorvo Inc.	Active-Semi International	325	Completed	Semi		No
3/27/2019	ON Semiconductor Corp.	Quantenna Communications Inc.	1,070	Completed	Semi		No
3/15/2019	Ideal Industries	Cree Huizhou Solid State Lighting Co Ltd	310	Completed	Semi		No
3/1/2019	NVIDIA Corp.	Mellanox Ltd.	6,900	Completed	Semi		No
12/18/2018	Cisco Systems	Luxtera	660	Completed	Semi		No
10/30/2018	MKS Instruments	Electro Scientific Industries	1,000	Completed	Semicap		No
9/1/2018	Renesas	Integrated Device Technology	6,700	Completed	Semi		No
7/1/2018	Broadcom Inc.	CA Technologies	18,900	Completed	Software		No
5/8/2018	Cohu	Xcerra Corp	796	Completed	Semicap		No
3/19/2018	KLA-Tencor Corp.	Orbotech Ltd.	3,200	Completed	Semicap		No
3/6/2018	Cree	Infineon RF Power	428	Completed	Semi		No
3/1/2018	Microchip Technology	Microsemi Corp	10,150	Completed	Semi		No
11/20/2017	Marvel Technology Group Ltd	Cavium Inc	6,018	Completed			No
10/5/2017	Dialog Semiconductor	Silego technology	276	Completed			No
9/22/2017	Canyon Bridge Capital	Imagination Technologies	743	Completed			No
6/12/2017	Synaptics Inc	Conexant Systems	341	Completed			No
3/29/2017	MaxLinear Inc.	Exar Corp	446	Completed			No
3/13/2017	Intel	Mobileye	15,300	Completed	Semi		No
2/13/2017	IDT	Gigapack	250	Completed	Semi		No
2/2/2017	Veeco	Ultratech	815	Completed	Semicap		No
12/21/2016	TDK	InvenSense	1,300	Completed	Semi		No
11/21/2016	MACOM	Applied Micro	770	Completed	Semi		No
11/2/2016	Broadcom	Brocade	5,900	Completed	Semi		No
10/31/2016	Inphi	ClariPhy	275	Completed	Semi		No
9/23/2016	Shanghai Capital	Analogix Semiconductor	500	Completed	Semi		Yes
9/13/2016	Renesas	Intersil	3,200	Completed	Semi		No
8/25/2016	Littelfuse Inc.	ON Semi's Ignition IGBT business	100	Completed	Semi		No
7/26/2016	Analog Devices	Linear Technology	14,800	Completed	Semi		No
7/17/2016	Softbank	ARM Holdings	32,000	Completed	Semi		No
6/15/2016	Cavium	QLogic	1,360	Completed	Semi		No
6/14/2016	JAC Capital	NXP's Standard Products Business	2,750	Completed	Semi		Yes
5/18/2016	ARM Holdings PLC	Apical Ltd	350	Completed	IP		No
5/13/2016	NavInfo Co. Ltd	Autochips Heifei Inc.	598	Completed	Semi		No
4/28/2016	Cypress	Broadcom's IoT	550	Completed	Semi		No
3/3/2016	Cisco Systems	Leaba Semiconductor Ltd	320	Completed	Semi		No
2/23/2016	MKS Instruments	Newport Corporation	980	Completed	Semicap		No
2/4/2016	FormFactor Inc	Cascade Microtech	296	Completed	Testing		No
1/13/2016	Microchip	Atmel	3,420	Completed	Semi		No
12/14/2015	Micron Technology	Intolera Memories	3,200	Completed	Memory		No
11/18/2015	ON Semiconductor	Fairchild Semiconductor	2,400	Completed	Semi		No
10/26/2015	Integrated Device Technology	ZMDI	310	Completed	Semi		No
10/21/2015	Sandisk	Western Digital	19,000	Completed	Memory		No
10/20/2015	MicroSemi	PMC-Sierra	2,400	Completed	Semi		No
9/30/2015	Mellanox	Ezchip	811	Completed	Semi		No
9/7/2015	Mediatek	Richtek	879	Completed	Semi		No
6/1/2015	Intel	Altera	16,700	Completed	Semi		No

- **Semiconductors consolidating to focus on gaining:**
 - Build scale and drive profitability improvements
 - End-market diversification
- **Consolidation should drive more stable revenue growth and margins**
 - Less competition leads to less pricing pressure
 - More market leadership and diversity
- **2015-2018 have seen \$100B+ per year in M&A deal activity versus the \$20-30B run-rate prior to this time period**
- **M&A characterized by “big getting bigger”...going forward we expect to start seeing a lot more M&A activity with the smaller/medium-sized companies, as there is pressure to drive scale to compete with much bigger competitors**

Annual M&A Volume (\$B) and Deal Count Picked Up Significantly in 2015...and Should Continue Going Forward

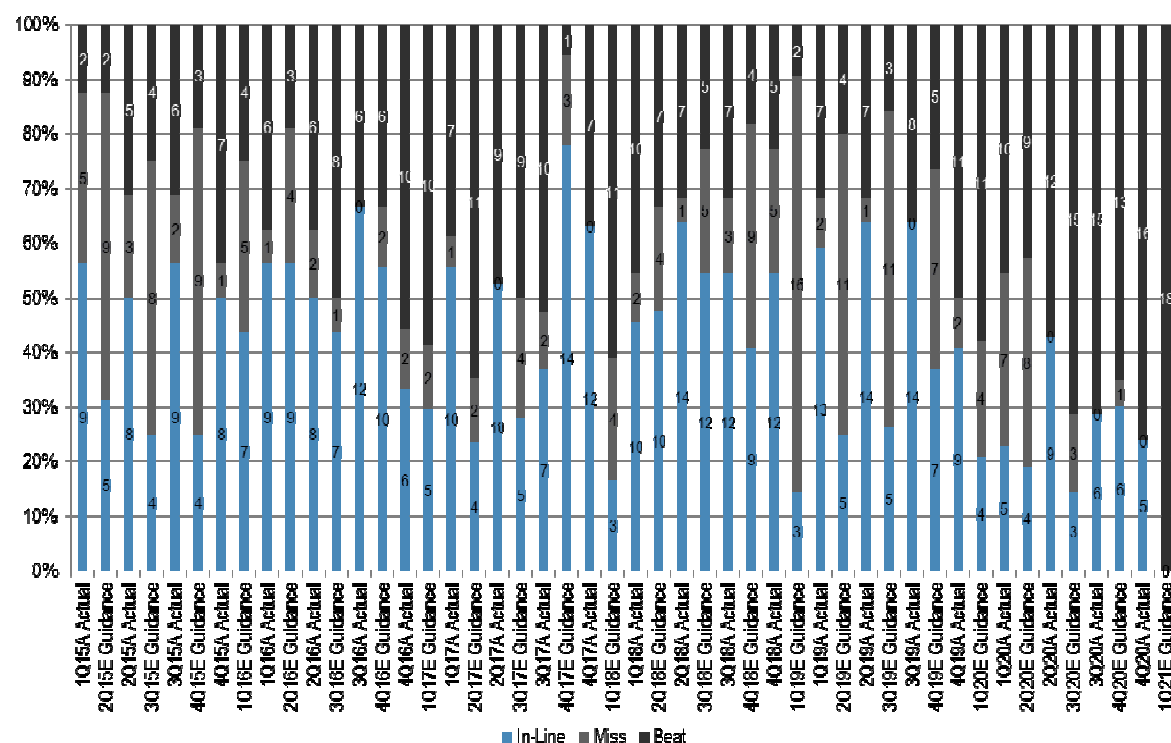


Only 40% Through the Current Up-cycle; Tight Supply Drives Multiple Qtrs of Strength

- **The number of companies in 4Q that delivered in-line/better out-quarter guidance rose to 100%. On average, CY21 estimates for the group were revised higher by ~9%**
 - We anticipate the market continuing to discount an improving economic outlook in 2021 (semis tend to discount 9 months forward)
- **Shipment trends were above historical normal seasonality in 4Q20, and we expect that to continue in 1Q21 as the global economy continues to expand post-COVID lockdown**
- **Continued positive EPS revisions in 2021, following three consecutive quarters of positive EPS revisions which began in 2Q20**
- **As we enter 2021, focus will begin to shift to 2022 earnings potential (semis tend to discount 9 months forward) - we see another 20%+ upside to out-year EPS estimates**
- **We estimate that the industry is only 40% through the current up-cycle. It will take another 4-6 quarters for supply to catch up with demand and inventories across the value chain to get back to normalized levels**
 - Companies are shipping 10-30% below current end-market demand
 - Equipment lead times are stretching from 7-9 months to 10-12 months (equipment order to production output)
 - It will take 3-4 quarters for supply to catch up with end-market demand.....and then another 1-2 quarters for value-chain inventory replenishment

100% Beat/Raise For The Group

- The number of companies in 4Q that delivered in-line/better out-quarter guidance rose to 100%. On average, CY21 estimates for the group were revised higher by ~9%
 - We anticipate the market continuing to discount an improving economic outlook in 2021 (semis tend to discount 9 months forward)
- We estimate that the industry is only 40% through the current up-cycle. It will take another 4-6 quarters for supply to catch up with demand and inventories across the value chain to get back to normalized levels
- Shipment trends were above historical normal seasonality in 4Q20 and we expect that to continue in 1Q21 as the global economy continues to expand post-COVID lockdown. 100% of the covered companies have guided 1Q sales better than expected



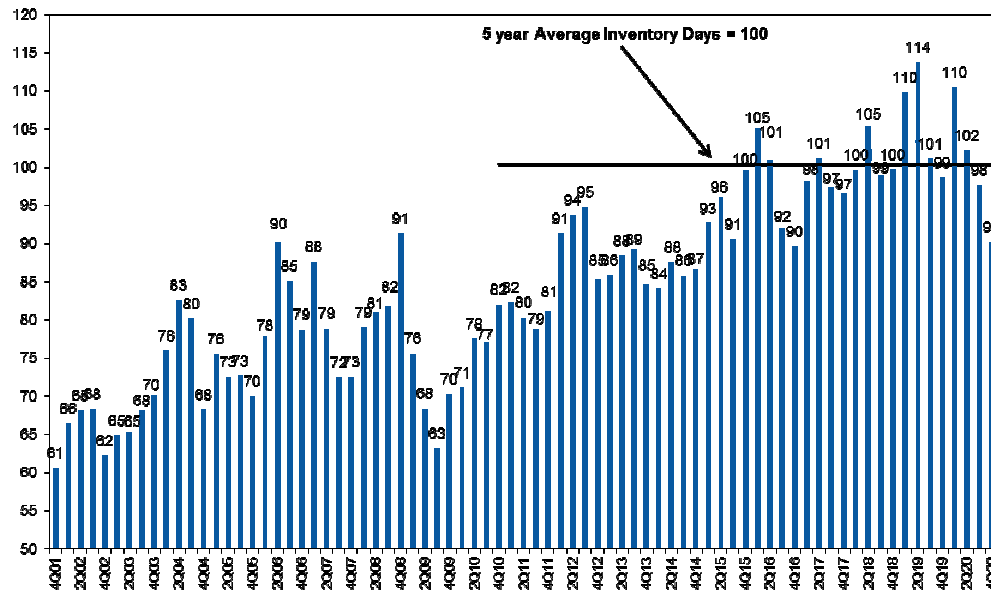
YTD industry Q/Q growth

Quarter	10-year Avg. Q/Q Growth	Actual
3Q14	8%	7%
4Q14	0%	0%
1Q15	-1%	-5%
2Q15	3%	1%
3Q15	7%	1%
4Q15	0%	-2%
1Q16	-2%	-5%
2Q16	3%	1%
3Q16	6%	12%
4Q16	-1%	5%
1Q17	-2%	0%
2Q17	2%	5%
3Q17	7%	11%
4Q17	-1%	6%
1Q18	-2%	-2%
2Q18	3%	6%
3Q18	7%	6%
4Q18	0%	-8%
1Q19	-6%	-10%
2Q19	-2%	1%
3Q19	13%	9%
4Q19	-1%	1%
1Q20	-3%	-3%
2Q20	3%	-1%
3Q20	6%	10%
4Q20	-1%	5%

Demand Environment Remains Strong and Supply-Side Indications Remain Tight

- **Semi days of inventory below historical trends:** 90 days in 4Q20, well-below the 5-year average of 100 days, and down from prior quarter and down Y/Y
- **Overall channel/customer inventories are at/near historic lows, and lead times are continuing to get stretched out.** Our companies continue to focus on supply expansion and supply procurement
- **Tight supply dynamics started well-before the auto/industrial component tightness observed in 4Q.** Leading edge capacity was already very tight by July 2020 due to the Sept Huawei component ban and strong 1H WFH dynamics in cloud and PCs

Days of Inventory, JPM Semi Universe



Source: Company reports.

	Distribution inventory days		Lead time	
	Current	Normal	Current	Normal
ADI	Below range	7-8 weeks		
MCHP	26 days	27-47 days	Extended	4-8 weeks
NXPI	1.6 months	2-3 months	Extended	16 weeks
ON	Low end of range	11-13 weeks	15 weeks	8-12 weeks
TXN		4.5 weeks	Stable	

Source: Company reports.

更多资料, 欢迎访问 www.wenku120.com

We Anticipate the Market Continuing to Discount an Improving Economic Backdrop into 2021 with Strong Demand Drivers in Place

- **Global GDP growth of 6.5% in CY21E (+8% in Q2, +7% in Q3)**
- **Semi industry growth of 10-12% in CY21E (bias upward)**
- **Cloud/hyperscale capex spending growth of 27% in CY21E (top 4 CSPs)**
- **PC shipments up 13-18% in CY21E after 13% growth in CY20**
- **5G smartphone unit shipment growth of >100% in CY21E**
 - **Total smartphone shipments up ~5% Y/Y**
- **5G basestation deployment growth of 35% in CY21E (China up 20% Y/Y – 2H weighted)**
 - **Semi companies are already seeing order visibility for 2H China 5G reacceleration**
- **Global light vehicle production growth of 13% in CY21E**
- **Capacity Optimized HDD growth of 13-15% and Client/Enterprise SSD shipments growth of 10-15%**

Source: Industry data and J.P. Morgan estimates.

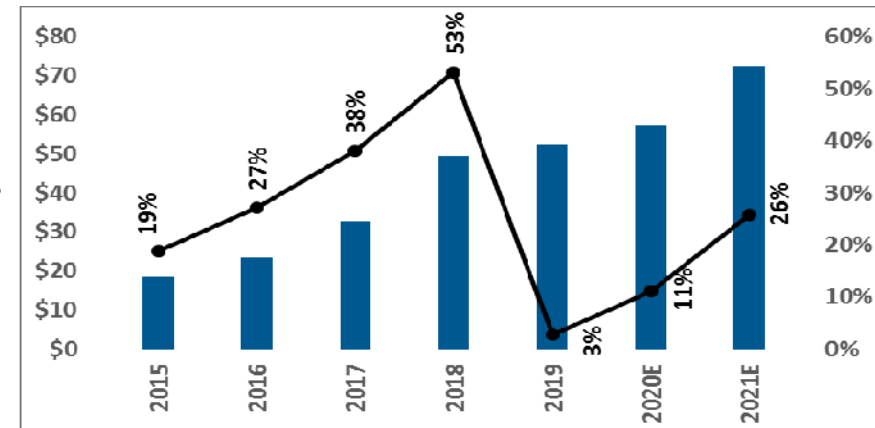
- **In 2020, several initiatives were proposed by US lawmakers to provide incentives for semiconductor companies to build/expand semiconductor manufacturing capabilities in the US and provide funding for Semiconductor R&D programs**
 - **CHIPS for America Act and American Foundries Act were two bipartisan initiatives that focused on incentives for domestic manufacturing**
 - **Both of these initiatives were rolled up in the National Defense Authorization Act (NDAA), which had bipartisan support and was passed by congress at the beginning of this year**
- The provisions authorized by the NDAA must still be funded through appropriations made by congress
- We believe up to \$3B of federal government funding for each specific domestic fab program – with total appropriation of \$18-20B and another \$12-15B for specific semiconductor R&D programs. We believe domestic fab programs that qualify for funding can include US and international companies (i.e. TSMC, Samsung)
- We believe US-based foundry/IDMs will likely benefit the most, especially those that have US defense related qualification
 - **Winners: GLOBALFOUNDRIES (#3 global foundry mkt share, US-based), Intel, Micron, Texas Instruments, Microchip, Analog Devices, ON Semiconductor, Qorvo, MACOM**
 - **Secondary Winners: TSMC (#1 global foundry share), Samsung (#2 global foundry share), NXP Semi, Infineon**

Strong Data Center Spending – Driving Strong Demand for Compute, Networking, and Memory/Storage Semiconductors

Look for companies levered to data center trends to outperform in 2021 across COMPUTE, NETWORKING and STORAGE/MEMORY after digestion cycle in 2H20

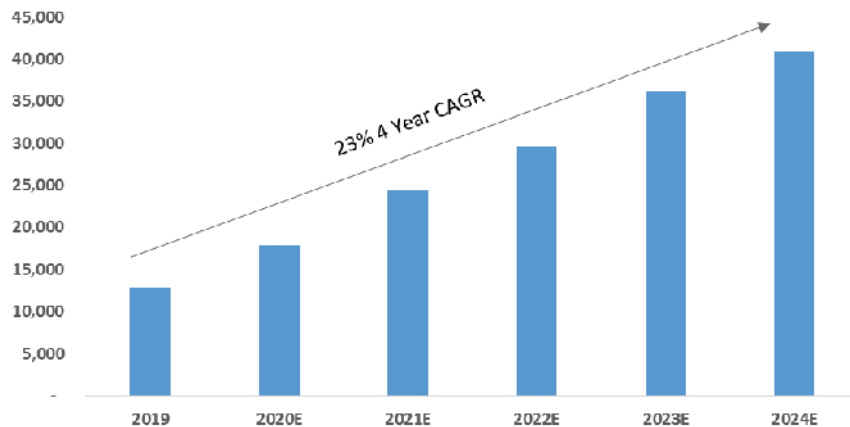
- Cloud Service Provider Spending (top 4) grew by 10% in 2020 and was up 6% in 2019. **We expect cloud spending to reaccelerate in 1H21 and grow 25%+ in 2021 with a 10-15% CAGR over the next few years**
- Cloud services revenue continue growing >40%+ Y/Y
- Over the next 5 years, CIOs should grow spending on public cloud by 4x
- Early ramp of new processors by Intel, AMD, NVIDIA, and ARM-Adopters
- Silicon switch ports (>25Gbps) to grow 23% CAGR - OW AVGO
- DRAM memory content in a cloud server is 50% higher than traditional enterprise server – OW MU
- Datacenter compute acceleration growing >25% CAGR, driven by higher complexity workloads (AI/Deep Learning, Analytics, etc.)

Cloud Service Provider Spending – Top 7 CSPs (2015-2021E)



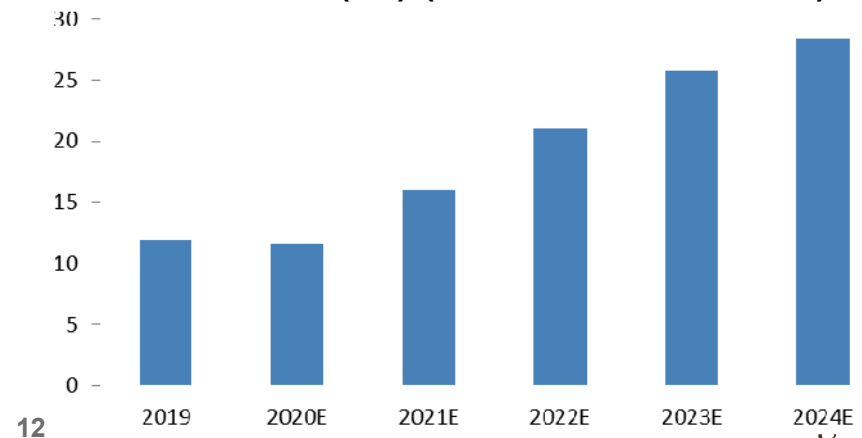
Source: Company reports, Bloomberg Finance L.P., and J.P. Morgan estimates.

Data Center 50G/100G/200G/400G Switch Port Growth (2019-2024E) 23%+ CAGR



Source: Dell'Oro

Cloud Computing Growth - Worldwide Accelerated Server Revenue(\$B) (25% CAGR 2020-2023)



Source: IDC and J.P. Morgan estimates

Custom Chip (ASIC) Market Experiencing a Resurgence in Activity as Large OEMs, Cloud, And Hyperscalers Look to Differentiate at the Silicon Level - \$10-12B Oppty

- Demand is rising for custom ASICs, because many of the large OEMs/CSPs/Hyperscalers are looking for more differentiation, better performance, lower power consumption and overall lower cost of ownership versus off-the-shelf chip solutions (or ASSPs)
- At the same time, these same customers do not have the capabilities to do large complex system-on-a-chip (SOC) designs, nor do they have the broad IP portfolio of on-chip design blocks, like high speed SERDES capabilities or high speed memory interface technology. They need to engage with semiconductor companies (ASIC companies) that have the IP and chip design expertise (Broadcom, Marvell, Intel, MediaTek, as examples).
- The digital custom ASIC chip market is a ~\$10-\$12B per year market opportunity:
 - Cloud/Hyperscale ASICS (AI processors, SmartNICs, Security/Video processors, Networking/Storage acceleration)
 - Telco/service provider equipment OEMs (5G basestation modem, 5G digital front end, 5G MIMO/Beamforming DSPs, Coherent DSPs for long

Snapshot of High Profile Custom ASIC Programs at Broadcom

Broadcom ASIC Customers	Programs	Technology	Status
Google	TPU1	28nm Technology	Deployed
Google	TPU2	16nm Technology	Deployed
Google	TPU3	16nm Technology	Deployed
Google	TPU4	7nm Technology	Begun production in 2Q20
Google	TPU5	5nm Technology	Target tape out 2021
Google	Switching	7nm Technology	Target tape out 2021
Facebook	ASIC	16nm Technology	Security Accel, 2020
Facebook	ASIC	7nm Technology	Video Accel, 2020
Facebook	ASIC	7nm Technology	Security Accel, 2021
Microsoft	ASIC	7nm Technology	Security Accel, 2020
Microsoft	ASIC	7nm Technology	SmartNIC
Tier-1 US Service provider	ASIC	16nm Technology	SmartNIC
Alibaba	ASIC	16nm Technology	SmartNIC
Fujitsu	ASIC	7nm Technology	AI acceleration
Cambricon	ASIC	7nm Technology	AI acceleration
SambaNova	ASIC	7nm Technology	AI acceleration
Nokia/Ericsson/ZTE	ASIC	16nm/7nm Technology	5G Basestation /Radio Head
Apple	ASIC	16nm	Next Gen iPhone Touch IC

New ASIC Programs for Broadcom/Marvell

- Marvell – 5nm ASIC with Microsoft - ARM CPU
- Marvell – 7nm/5nm Cloud Networking ASIC
- Broadcom – 20+, 7nm ASIC designs underway
- Broadcom – 6, 5nm ASIC designs underway
- Broadcom – 3nm ASIC development underway for next gen Tier-1 Cloud AI processor
- Broadcom – new wireless charging ASIC for iPhone 13 and new touch controller ASIC

Source: J.P. Morgan Research

J.P.Morgan

Broadcom (AVGO): Driving Strong Cloud Networking Upgrade In 2021, Strong Custom ASIC (custom chip) Pipeline...

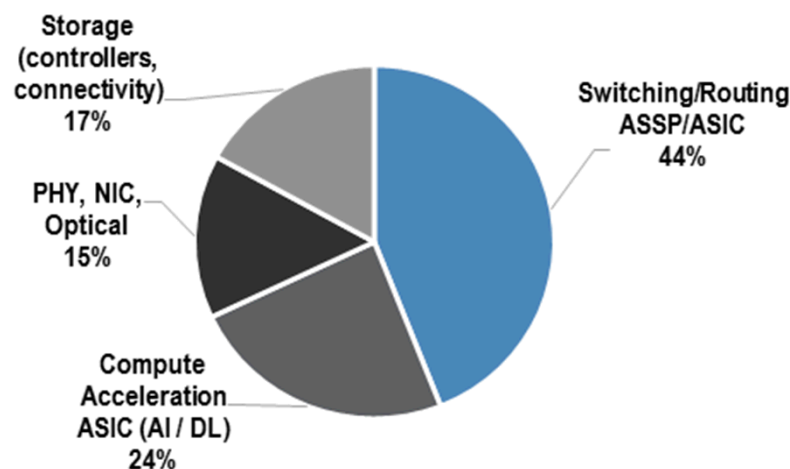
- **Still viewed as an Apple iPhone Supplier...market starting to appreciate the diversification of the business...~25% of total revenues are now exposed to cloud datacenter**
- **Category Killer in Cloud Datacenter Networking...>85% share of merchant and ASIC switching silicon opportunity ~\$3B per year growing 10-15% Y/Y**
 - Tomahawk 3 (50G PAM4 per port) production ramp started 2H18 – significant upgrade cycle in 2020/2021
 - Tomahawk 4 commenced shipping in 2H20
 - Tomahawk 5 set to tape out in 1H21
 - Not only leader in switch/routing – but also NIC, PHY, optical silicon as well to support the switch silicon
- **Category Killer in Artificial Intelligence Custom Processor Chips** to customers like Google (TPU1/2/3/4 and TPU5 beg. in 2022), Fujitsu, Intel, and several others...>\$1B business (from zero base in 2016)
- **Strong cloud infrastructure spending not only benefits Broadcom's leadership in switching/routing, but also its leadership in enterprise/cloud storage silicon** – Enterprise SSD Controllers, HDD capacity cloud drive controllers, Storage HBA, Storage Systems connectivity
- **Dividend at \$14.4 (+11% Y/Y) and given continued strong FCF of the company and healthy fundamentals, we forecast another double-digit % dividend raise next fiscal year to ~\$16/share next year**

Cloud Data Center Network/Storage Silicon SAM Opportunity and Growth

Segments	\$ SAM 2024e	SAM CAGR 2020e- 2024e
Data Center Networking	~ \$8.5B	13-15%
Compute Acceleration		
Data Center Storage	~ \$2.2B	5%
Combined	~ \$11B	~ 10-15%

Source: J.P. Morgan estimates.

Cloud Datacenter Networking/Compute Acceleration ASIC/Storage Revenue Mix (25% of Total Revenues)

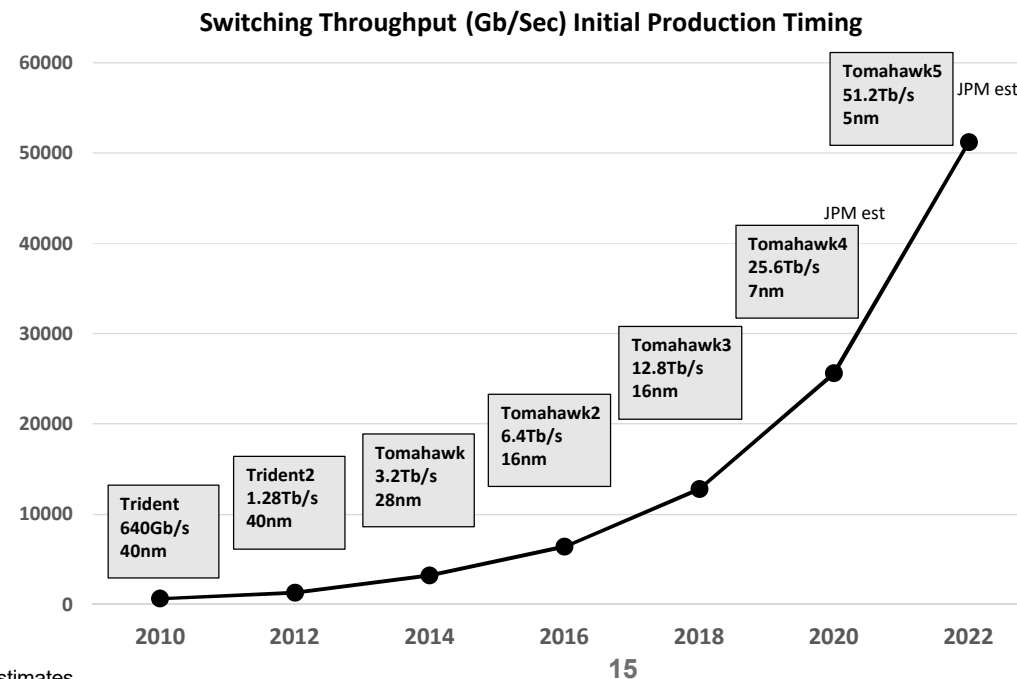


Source: J.P. Morgan estimates.

Broadcom (AVGO): Continues to Drive Moore's Law Performance in Its Datacenter Switching Family...Staying 1-2 Steps Ahead of Competitors

- Ramping Tomahawk 3 now – driving 200/400Gbps upgrade cycle in cloud and hyperscale datacenters
- Commenced shipments of Tomahawk 4 in 2H20 – augment 400Gbps upgrade cycle, more port density/power efficiency
- Tomahawk 5 (51.2Tb/sec) – 5nm, in design now – tape out 1H21 – shipments 2022 – drive the next-gen 800G cycle
- Tomahawk 6 (100Tb/sec) – 5nm, early architecture development with co-packaged optics

Broadcom Drives Moore's Law Performance in Switching (2x increase in switching throughput every 2 years)



Broadcom Infrastructure Software Segment – Focused on Mission Critical, Driving 65-70% EBIT Margins...Longer Term Total Company 60% EBITDA Margins and 50% FCF margins...

- **Broadcom should continue to build-out its Infrastructure Software Business focused on mission critical applications:**
 - SAN Storage (switching/HBA/Software/Silicon) – Brocade, Emulex, LSI
 - Mainframe Software (transaction processing) – CA
 - Enterprise Security Software – Symantec
 - Leader in endpoint protection, web gateway, data loss prevention (DLP)
 - Potential LT synergies with silicon leadership (already engaged on security acceleration ASIC silicon with Facebook and Microsoft). Stingray silicon SmartNIC platform focused on security.
- **Feedback from large customers of the Infrastructure Software Segment:**
 - SAN Storage, Mainframe, Enterprise security ARE MISSION CRITICAL APPLICATIONS
 - See stable spending trend for these applications going forward
 - On Symantec:
 - Proven scalability (100k's endpoint protection)
 - Proven scalability across on-prem/hybrid/cloud architectures
 - More confidence on AVGO mgmt. driving LT roadmaps and required R&D investments
- Brocade/CA already driving 70% EBITDA margins and SYMC to drive 65%+ EBITDA margins post synergies...LT can see total Broadcom driving ~58-60% EBITDA margins, 50% FCF margins and DD% earnings and FCF/share growth

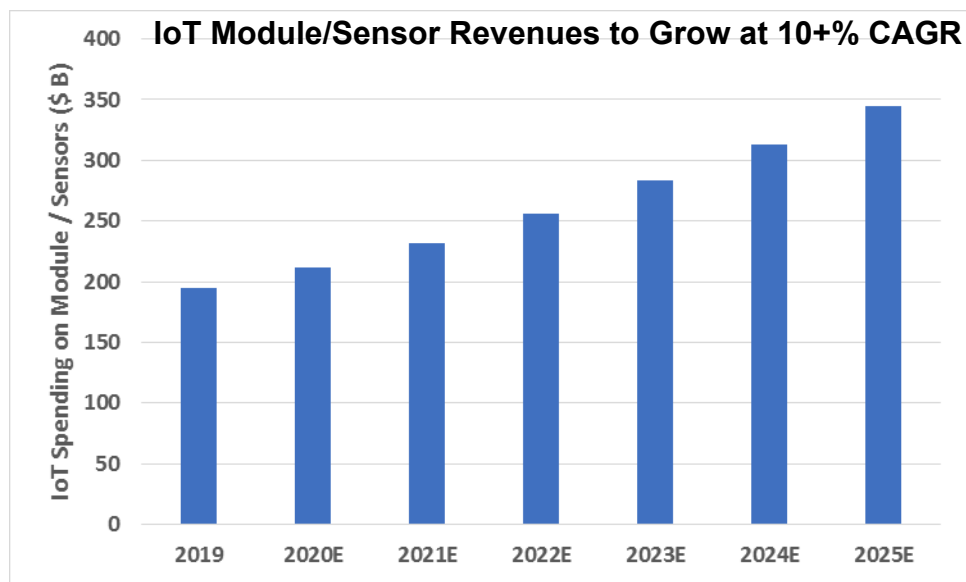
Internet of Things Semiconductor Opportunities Expanding Beyond Consumer with Wireless Connectivity to Deliver Outsized Growth

IoT represents strong double-digit semiconductor growth opportunity

Growth shifting from more consumer-focused end-markets to industrial and automotive

Key drivers:

- Growth from consumer applications such as smart home, smart speakers, wearables, etc. likely to moderate, while Industrial IoT and Automotive IoT growth likely to accelerate
- Wireless Connectivity (e.g. Wi-Fi and Bluetooth) unit growth of >15%
 - 802.11 (Wi-Fi) – 15-17% CAGR
 - 802.15.4 (Inc. ZigBee, Thread) – 15-17% CAGR
 - Bluetooth – 25%+ CAGR
 - Other (Inc. Z-wave Proprietary) - 13-15% CAGR



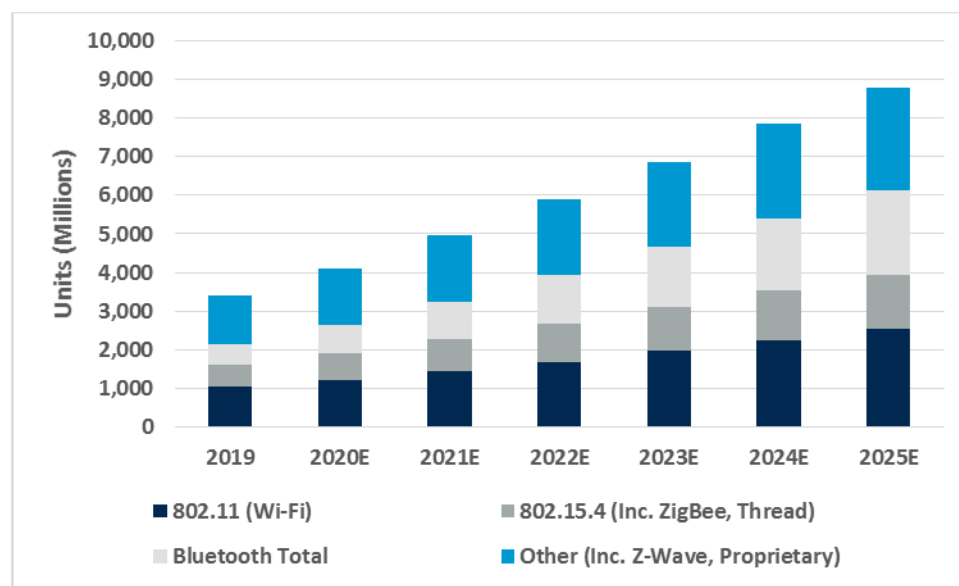
Source: IDC and J.P. Morgan estimates.

IoT Semiconductor Revenue Growth by End-Market 2019-2024E

End-Market	CAGR (2019-2024E)
Consumer	10-11%
Industrial	13-15%
Automotive	>30%
Total:	15-20%

Source: Gartner and J.P. Morgan estimates.

Wireless Connectivity Such as Wi-Fi and Bluetooth to Deliver Outsized Growth



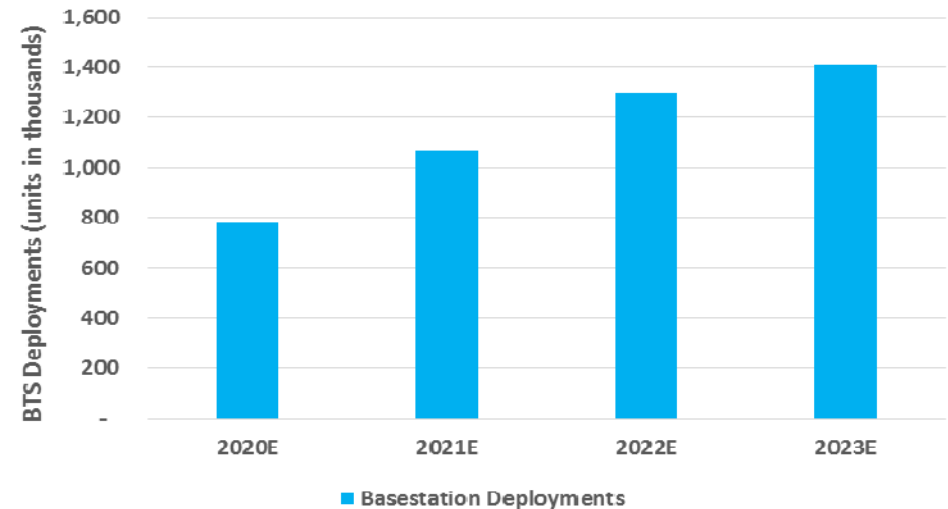
Source: Gartner and J.P. Morgan estimates.

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5G Wireless Infrastructure: Anticipate strong growth in 2021 and through 2023

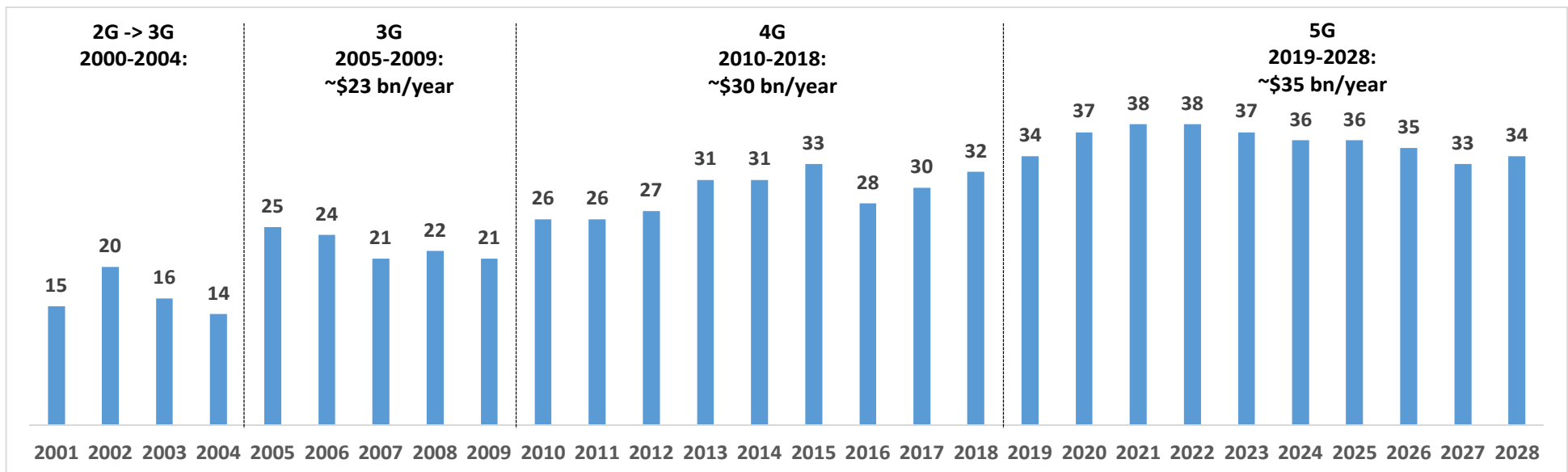
- **5G Basestation Deployments – Growing by more than 22% CAGR (2020-2023E)**
- 5G Basestation global deployments up 35% Y/Y in 2021
- Deployments continue to be led by China (our research colleagues forecast 620k-640k BTS in 2020 and 700k-840k BTS in 2021) and are expected to be up 20% Y/Y in 2021
- Expect North America activity to pick up in second half of this year followed by Europe in 2022
- Positive for MRVL, AVGO, INTC, QRVO, ADI, TXN, XLNX, IPHI

5G Basestation Deployments (2020E -2023E)



Source: IDC and J.P. Morgan estimates.

Carrier Infrastructure Spending



Source: Altman Vilandrie, CTIA, ExteNet

RF Semis: 5G Complexity Benefits RF Market Leaders QRVO, AVGO and SWKS

■ RF market growth reaccelerating with mix shifting to 5G

- Ramp of 5G to meaningfully increase RF market opportunity primarily on new sub-6 GHz content, millimeter wave also additive over the next few years
 - ~\$5-\$7 of incremental sub-6 GHz content
- Complexity challenges in advanced 4G and 5G leading to use of highly integrated modules
- Anticipate double-digit % market growth CAGR through 2022 with potential upside

■ Qorvo, Skyworks and Broadcom remain well-ahead of the competition

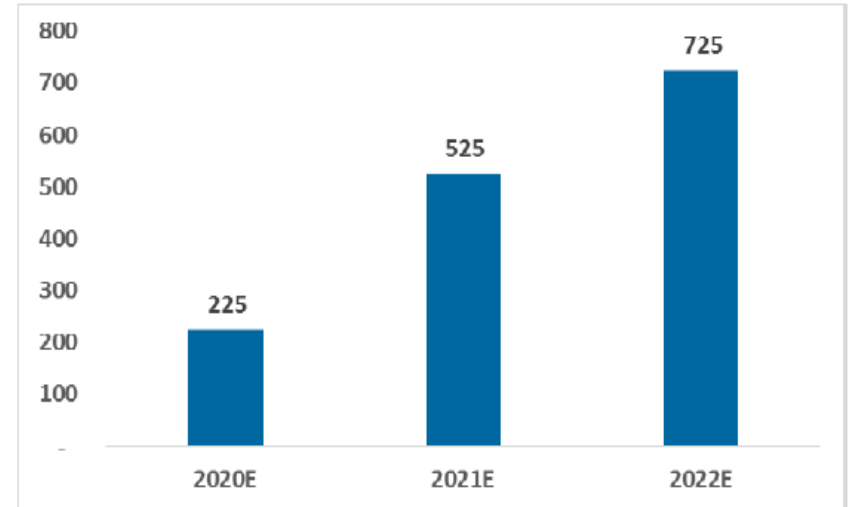
- Core base component expertise (PAs, switches, premium filters, etc.)
- Years of experience building highly integrated modules
- Use of substandard RF could result in poor performance and impact form factor, including impact on signal integrity (i.e. dropped calls), reduced battery life and worse overall user experience
- Difficult to insource with lack of foundry model / merchant filter vendors
- We maintain our view of QRVO, SWKS and AVGO being key beneficiaries of the 5G ramp as the companies are uniquely positioned to deliver the highest performing RF
- Non-Mobile businesses of QRVO and SWKS likely to drive double-digit % revenue growth
- Driving strong gross, operating and free cash margin expansion
- Supportive of further upside in shares over the next 18-24 months

Content per Unit Growth and RF TAM Growth

	CAGR (2019-2022E)
Smartphone Unit Growth Framework	0-2%
Average RF Content Per Device Growth	~10%
RF Market Growth	10-12%

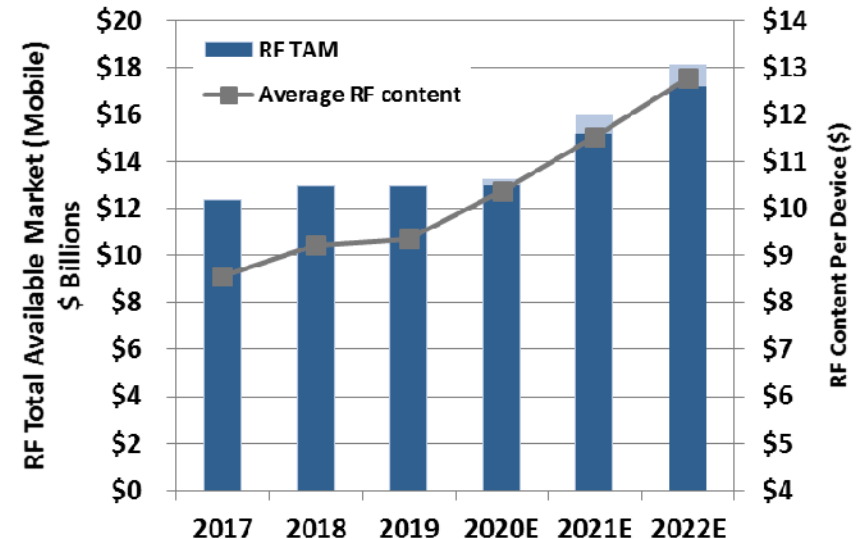
Source: J.P. Morgan estimates.

5G Smartphone Estimates



Source: J.P. Morgan estimates.

RF Market Size and RF Content per Unit Growth Framework



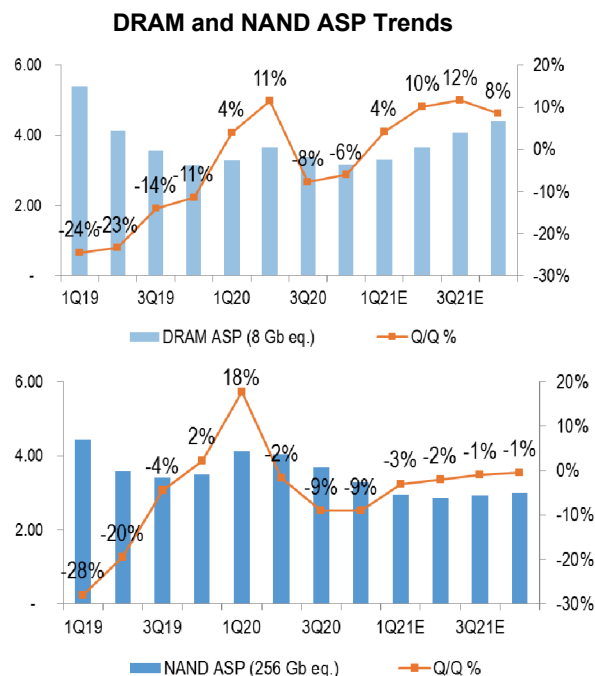
Source: J.P. Morgan estimates.

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Demand Growth Accelerating in Memory, Pricing Should Improve Meaningfully in DRAM in Early 2021 While Price Declines in NAND Moderate

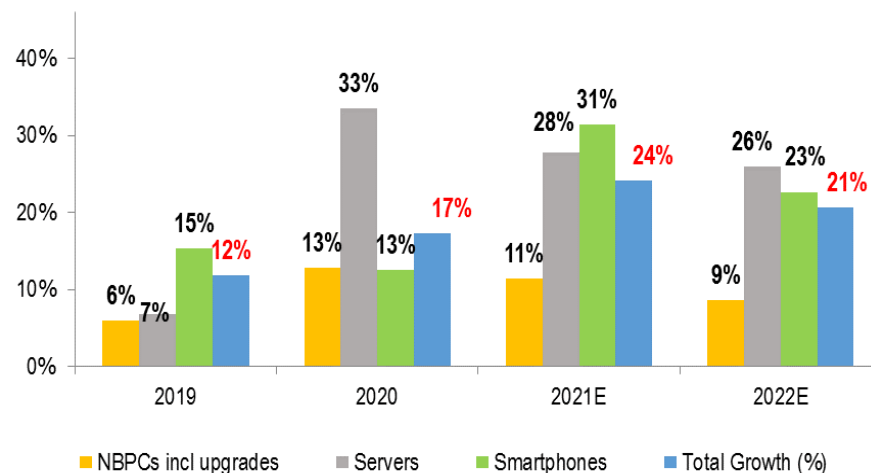
■ Bit Demand in DRAM and NAND to accelerate in 2021

- DRAM bit demand should increase to >20% with strong demand for server and mobile DRAM
- NAND bit demand should increase to ~40%, led by SSDs and mobile devices
- Supply tightness in DRAM as a result of lower DRAM capex in past two years should lead to improved pricing and ASP increases in 2021
- NAND market still in oversupply – ASP declines should decelerate later in 2021
- Improving Memory fundamentals, especially in DRAM, positive for OW-rated MU in 2021



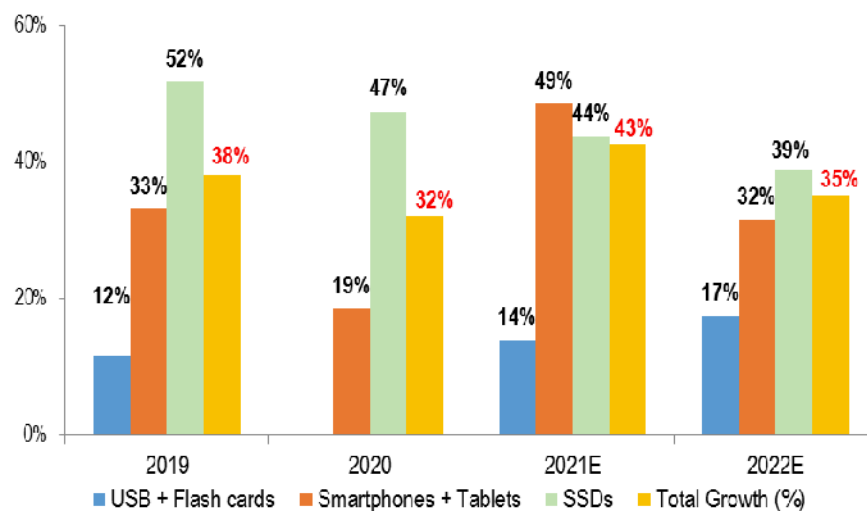
Source: WSTS and J.P. Morgan estimates

DRAM Bit Demand by Market



Source: Gartner and J.P. Morgan estimates.

NAND Bit Demand by Market



Source: Gartner and J.P. Morgan estimates.

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Semiconductor Capital Equipment: Remain OW LRCX, KLAC and AMAT

- **Following a low-teens% spending increase in wafer fab equipment (WFE) in 2020, we expect spending in 2021 to increase by ~16% to nearly \$70B:**
 - The semiconductor industry has entered a more stable and less cyclical growth phase, which should drive a more predictable trend of semi unit growth and therefore capex growth and semicap equipment revenue growth
 - The current Moore's Law-driven equipment spending cycle adds to the predictability and a growth vector to equipment spending
 - Rising capital intensity is associated with next-generation manufacturing technology inflections such as FinFET, 3D NAND, lower-resistance interconnects, multiple-patterning, and integrated packaging
 - Memory spending (DRAM and NAND) was muted in 2020 as memory makers aim for S/D balance and continued profitability → We expect Memory spending to accelerate to double-digit % in 2021, led by DRAM
 - Foundry/Logic spending in CY20 exiting the year was strong and we see continued broad-based growth across leading and lagging edge technologies in CY21
 - Domestic China semi manufacturers have begun to fill pilot lines with slight upside to prior estimates and we see continued strong investments in China in 2020 as domestic manufacturers continue to come up the learning curve
 - **We expect wafer fab equipment (WFE) spending to grow 15%-17% in 2021 led by continued strength in Foundry/Logic spending and recovery in Memory led by DRAM on broad-based demand for compute, networking, acceleration, 5G, etc. that is driving continued strength in Foundry and increased Memory spending.**
- **We anticipate companies under coverage to drive revenue growth better than WFE spending in 2021 on market share gains, SAM expansion, and solid service revenue growth**
- **Semicap companies are more profitable than in past downturns, with CY22 earnings power of >\$30 for LRCX, >\$15 for KLAC and >\$6 for AMAT, which implies 20+% upside in the stocks**
- **KLAC is our top semicap pick, as a diversified leader poised to benefit from new technology migration and positive exposure to EUV lithography adoption**

Total Capex Spending by Semi Manufacturers (2013-2021E)

Company	2013	YoY%	2014	YoY%	2015	YoY%	2016	YoY%	2017	YoY%	2018E	YoY%	2019	YoY%	2020E	YoY%	2021E	YoY%
IDM																		
Intel	\$10,711	-2.6%	\$10,105	-5.7%	\$7,326	-27.5%	\$8,025	9.5%	\$9,300	15.9%	\$11,900	28.0%	\$14,400	21.0%	\$12,759	-11.4%	\$11,000	-13.8%
Texas Instruments	\$507	2.4%	\$410	-19.1%	\$551	34.4%	\$531	-3.6%	\$550	3.6%	\$1,130	105.5%	\$925	-18.1%	\$900	-2.7%	\$1,200	33.3%
Others	\$3,408	-40.3%	\$3,514	3.1%	\$3,983	13.4%	\$3,612	-9.3%	\$5,100	41.2%	\$4,850	-4.9%	\$4,825	-0.5%	\$4,850	0.5%	\$5,600	15.5%
Total	\$14,626	-15.0%	\$14,029	-4.1%	\$11,860	-15.5%	\$12,168	2.6%	\$14,950	22.9%	\$17,880	19.6%	\$20,150	12.7%	\$18,509	-8.1%	\$17,800	-3.8%
% of Total Capex	29%		26%		22%		20%		17%		19%		22%		18%		16%	
MEMORY																		
Samsung Memory	\$6,930	20.1%	\$9,700	40.0%	\$10,320	6.4%	\$9,100	-11.8%	\$19,700	116.5%	\$18,000	-8.6%	\$16,100	-10.6%	\$17,200	6.8%	\$20,100	16.9%
SK hynix	\$3,300	-6.8%	\$4,800	45.5%	\$4,900	2.1%	\$5,400	10.2%	\$8,500	57.4%	\$15,200	78.8%	\$9,900	-34.9%	\$8,450	-14.6%	\$9,475	12.1%
Nanya/Inotera *	\$485	127.3%	\$809	66.8%	\$1,955	141.7%	\$1,580	-19.2%	\$1,100	-30.4%	\$675	-38.6%	\$180	-73.3%	\$460	155.6%	\$520	13.0%
Micron + IM JV	\$1,620	-14.7%	\$3,140	93.8%	\$4,200	33.8%	\$5,150	22.6%	\$5,500	6.8%	\$9,150	66.4%	\$8,000	-12.6%	\$9,000	12.5%	\$9,000	0.0%
Intel Memory	\$0	NM	\$0	NM	\$0	NM	\$1,600	NM	\$2,500	56.3%	\$3,300	32.0%	\$1,800	-45.5%	\$1,500	-16.7%	\$1,500	0.0%
Japan+WD	\$2,150	6.4%	\$2,500	16.3%	\$3,500	40.0%	\$4,000	14.3%	\$5,000	25.0%	\$5,000	0.0%	\$6,000	20.0%	\$6,000	0.0%	\$6,000	0.0%
Others, inc. Domestic China	\$654	6.4%	\$679	3.8%	\$320	-52.9%	\$475	48.4%	\$4,250	794.7%	\$5,300	24.7%	\$4,385	-17.3%	\$5,800	32.3%	\$6,800	17.2%
Total	\$15,139	7.7%	\$21,628	42.9%	\$25,195	16.5%	\$27,305	8.4%	\$46,550	70.5%	\$56,625	21.6%	\$46,365	-18.1%	\$48,410	4.4%	\$53,395	10.3%
% of Total Capex	30%		40%		47%		46%		54%		60%		50%		48%		47%	
FOUNDRY																		
TSMC	\$9,690	16.7%	\$9,522	-1.7%	\$8,123	-14.7%	\$10,200	25.6%	\$10,900	6.9%	\$10,500	-3.7%	\$14,900	41.9%	\$17,200	15.4%	\$26,500	54.1%
Globalfoundries	\$4,000	5.3%	\$3,500	-12.5%	\$2,500	-28.6%	\$1,500	-40.0%	\$2,500	66.7%	\$2,500	0.0%	\$700	-72.0%	\$700	0.0%	\$1,400	100.0%
Samsung Logic	\$4,660	-34.4%	\$2,848	-38.9%	\$3,108	9.1%	\$2,286	-26.4%	\$6,600	188.7%	\$3,250	-50.8%	\$6,500	100.0%	\$7,150	10.0%	\$9,000	25.9%
Others	\$1,879	-16.5%	\$2,436	29.6%	\$3,245	33.2%	\$6,325	94.9%	\$4,900	-22.5%	\$3,450	-29.6%	\$3,575	3.6%	\$8,995	151.6%	\$5,500	-38.9%
Total	\$20,229	-5.7%	\$18,306	-9.5%	\$16,976	-7.3%	\$20,311	19.6%	\$24,900	22.6%	\$19,700	-20.9%	\$25,675	30.3%	\$34,045	32.6%	\$42,400	24.5%
% of Total Capex	40%		34%		31%		34%		29%		21%		28%		34%		37%	
Total	\$49,994	-5.2%	\$53,963	7.9%	\$54,031	0.1%	\$59,784	10.6%	\$86,400	44.5%	\$94,205	9.0%	\$92,190	-2.1%	\$100,964	9.5%	\$113,595	12.5%

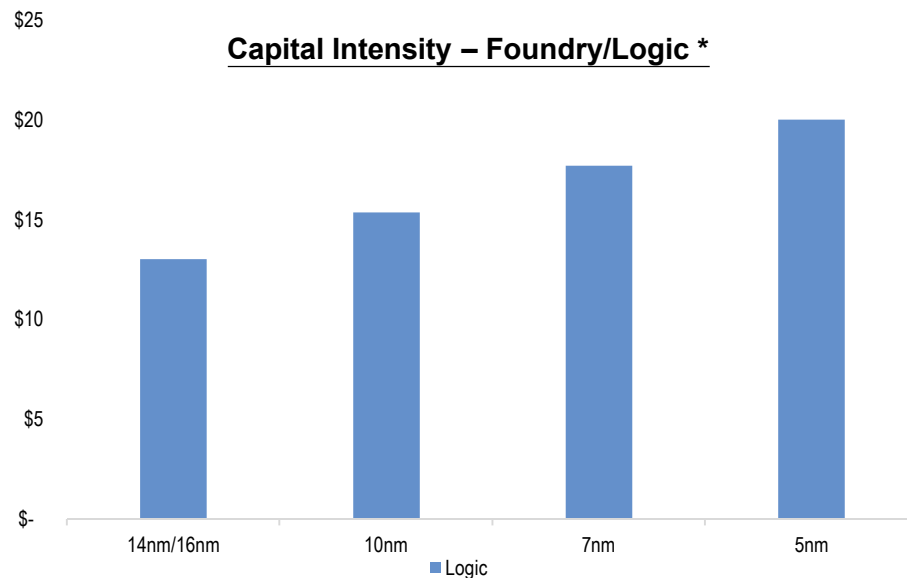
Source: Company reports, J.P. Morgan estimates.

Note: Samsung and SK Hynix covered by JPM analyst JJ Park; TSMC, UMC and SMIC covered by JPM analyst Gokul Hariharan. Inotera acquired by Micron on December 6, 2016.

Capital Intensity Increasing Across Device Types – Positive for Semi Equipment

Capital Intensity Increasing Across Device Types

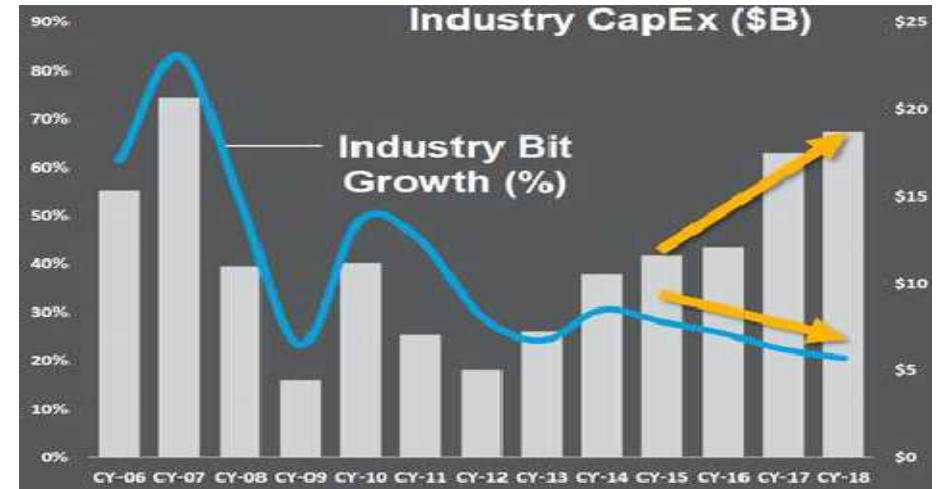
- Increasing capex to drive bit growth for both DRAM and NAND; NAND capital intensity for 12X layer >50% higher than 4X layer NAND
- Require increasing capex to drive bit growth for both DRAM and NAND
- Capital intensity increasing for Foundry/Logic even as EUV has begun ramping; 5nm capital intensity >50% higher than 14nm/16nm
- Increasing capital intensity is positive for semiconductor equipment companies, as spending on equipment will likely have a higher floor and be less cyclical over the next several years



Source: Tokyo Electron SEMICON West 2019, J.P. Morgan estimates

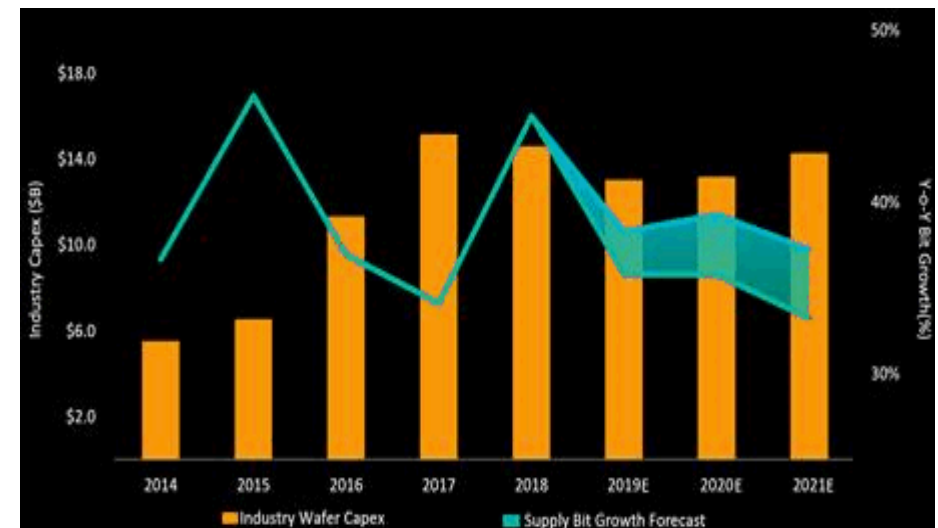
* \$B of WFE required for 100k wafer starts per month (WSPM) greenfield capacity

DRAM Capex vs. Bit Growth



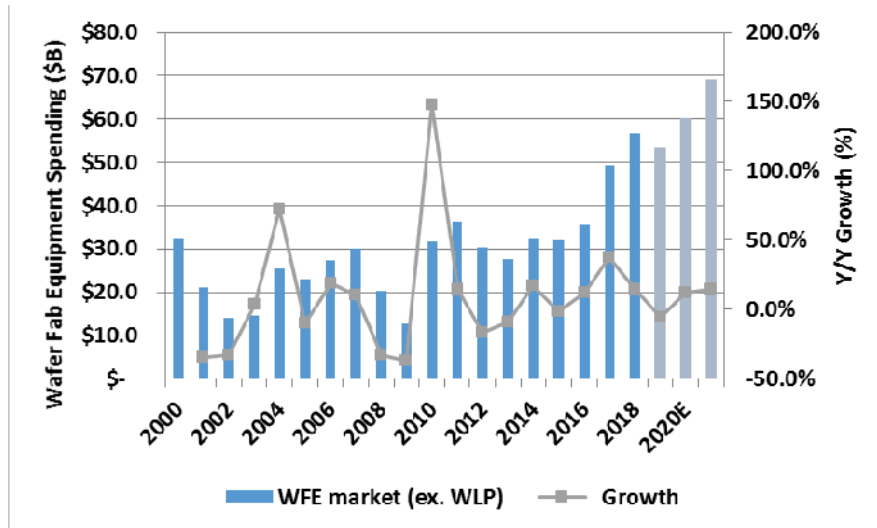
Source: Micron, May 2018 Analyst Day

NAND Capex vs. Bit Growth



Source: Western Digital, December 2018 Analyst Day
Forward Insights, 2018, WDC. 2019-2021 Projection

WFE Forecast and Key Programs for Semiconductor Manufacturers in 2021



Source: Industry data and J.P. Morgan estimates.

We estimate WFE spending is on track to increase by ~16% in 2021 to nearly \$70B

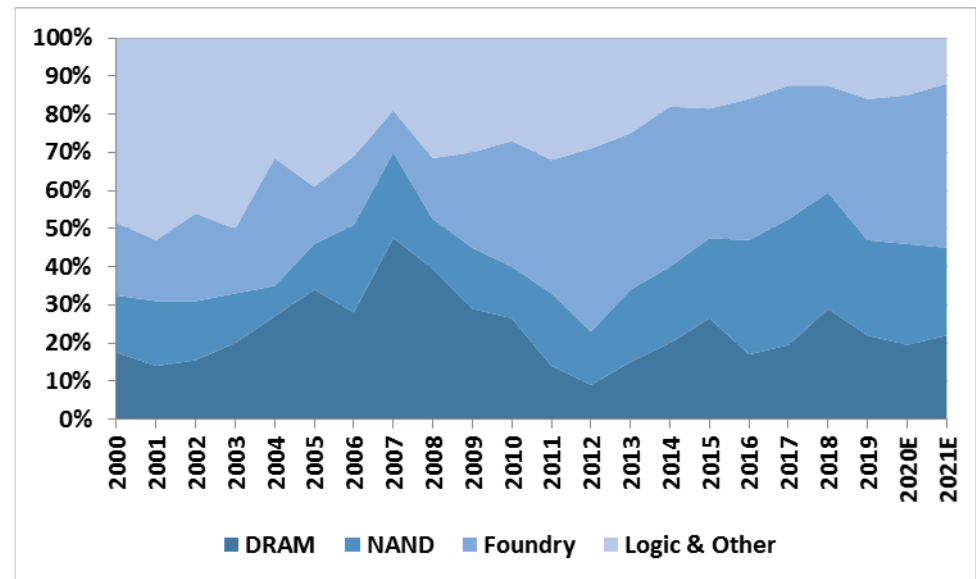
We expect Memory to recover in 2021 led by DRAM on improving S/D fundamentals with Foundry/Logic spending sustainable

Key drivers:

- Following muted Memory WFE in 2020 held back on supply discipline, we expect Memory spending to accelerate to double-digit % in 2021, led by DRAM
- Expect continued Foundry/Logic spending strength in 2021; broad-based across leading and lagging edge technologies
- China spending to remain strong in 2021 as local manufacturers come up the learning curve

Manufacturer	Segment	Technology
China	Foundry	14nm and above (Various)
China	Memory (DRAM)	1Xnm, 1Y DRAM (Changxin Memory Technologies, Hefei)
China	Memory (NAND)	128 layer 3D NAND (YMTC, Wuhan)
Globalfoundries	Foundry	12nm/14nm FinFET (New York)
Intel	Logic	10nm/7nm/5nm FinFET (Israel, Oregon, Arizona)
Micron	Memory (NAND)	3D NAND – 176 L Replacement Gate (Singapore expansion)
Micron	Memory (DRAM)	1αnm DRAM (Taiwan and Hiroshima Japan, expansion)
Samsung	Foundry/Logic	5nm FF/3nm GAA (Hwaseong & Pyeongtaek, South Korea)
Samsung	Memory (NAND)	128/176 L 3D NAND (Pyeongtaek, Korea & Xian, China)
Samsung	Memory (DRAM)	1α nm DRAM (Pyeongtaek, South Korea)
SK hynix	Memory (NAND)	128 3D NAND (Cheongju, South Korea)
SK hynix	Memory (DRAM)	1αnm DRAM (Incheon, Korea; Wuxi, China)
WDC / Partner	Memory (NAND)	112L BiCS 5 3D NAND (Yokkaichi and Kitakami Japan)
TSMC	Foundry	5nm/3nm FF & legacy (Taiwan)
UMC	Foundry	14nm and above

Source: Industry data and J.P. Morgan estimates.



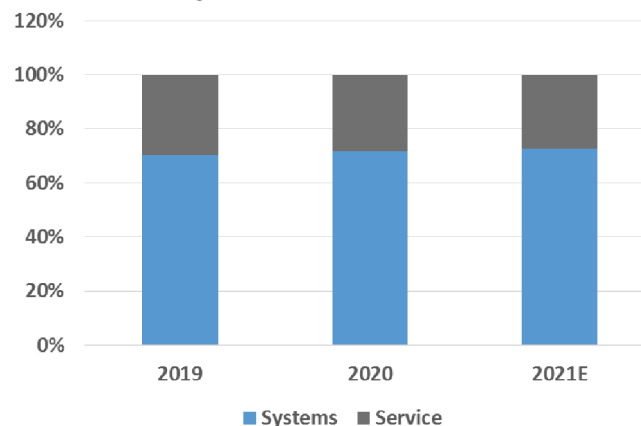
Source: Industry data and J.P. Morgan estimates.

Service / Installed Base Businesses for Applied, KLA and Lam Research Delivering Strong and Relatively Stable Growth with Strong Profitability and Free Cash Flow Generation

Service and Installed Base businesses of AMAT, KLAC and LRCX helping companies outperform relative to WFE spending with strong profitability and cash generation

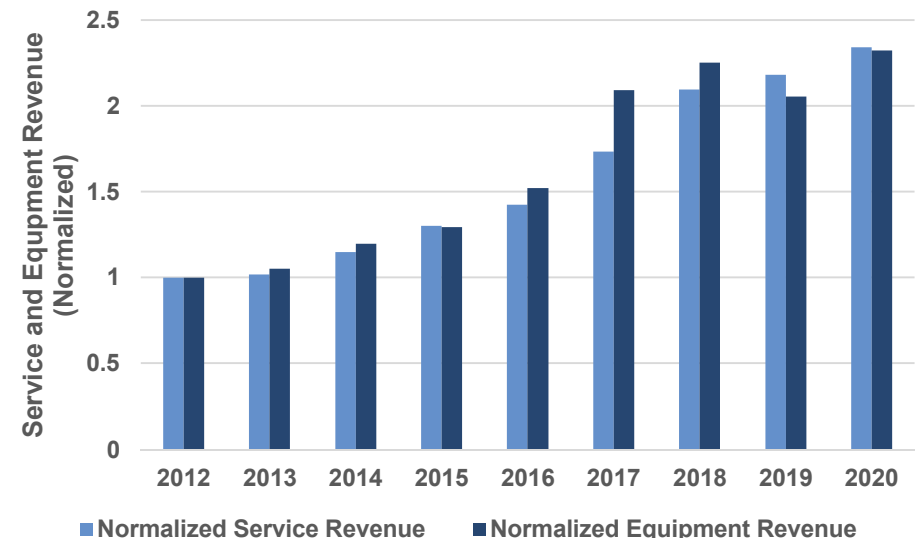
- The service businesses of the large caps under coverage remain underappreciated in our view
- **Growing at double-digit rate (2014-2021E CAGR)**
- **Generally accounts for 25-35% of revenue** ^{^ Excluding AMAT Display and Other}
- **More stable than equipment sales** and grew in aggregate in 2019 vs. system sales down ~10% on average
- Increasing contribution of **annuity-like long-term service agreements**
- Lower than corporate average gross margin, but generally **accretive** to operating profitability and free cash flow
- Service contribution is an important reason why semiconductor equipment companies under coverage are roughly **4 times more profitable in the recent downturn** compared to the prior downturn in 2012/2013

Service vs. Systems Revenue – 2019-2021E *



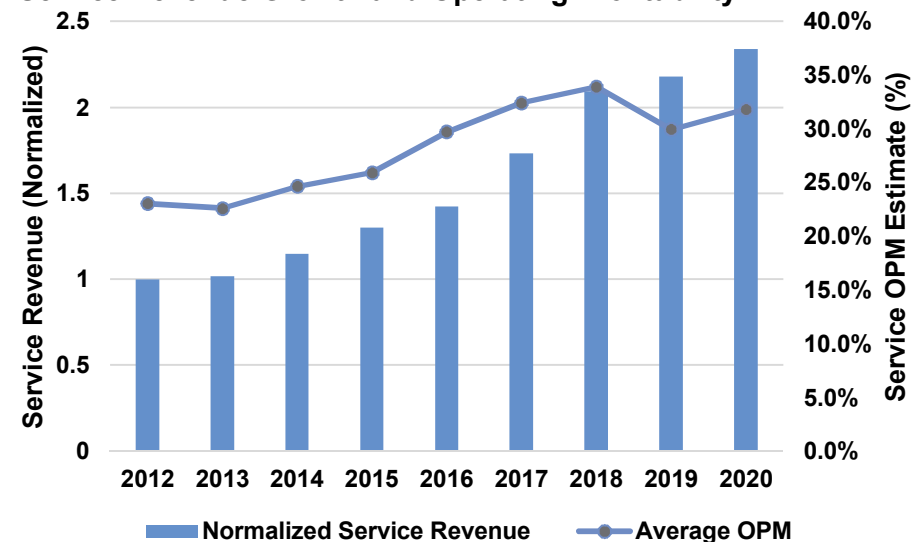
Source: Company reports and J.P. Morgan estimates. * Combined AMAT, KLAC and LRCX average

Service Revenue Growth vs. Systems Revenue Growth *



Source: Company reports and J.P. Morgan estimates. * Combined AMAT, KLAC and LRCX normalized

Service Revenue Growth and Operating Profitability *



Source: Company reports and J.P. Morgan estimates.

25 * Combined AMAT, KLAC and LRCX

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Top Semicap Pick KLAC Dominates Process Control

- **KLAC dominates the process control market with nearly 5x more market share than their nearest competitor**
- **Increased diversification with exposure to fast-growing specialty semiconductor markets (Adv. Packaging, Compound Semis, MEMs, etc.) and key enabler of yield and manufacturability solutions for Printed Circuit Board (PCB) and Flat Panel Display (FPD) markets**
- **Best in class margin profile ~60%+ GMs, 35%+ OPMs, 28-30% FCF margins...\$700M of R&D spending power dedicated to process control**
 - KLA's R&D spending is roughly equal to the revenues of its #2 competitor and 1.2x-6x larger than the revenues of its next 8 competitors
- **Grew their process control systems business 2.5% last year when total WFE was down 6%, and gained 270 basis points of market share in process control**
- **6% growth and 420 bps in share gain in pattern wafer inspection driven by Gen 5 optical and new e-beam wafer inspection platforms**
- **37% growth and 500 basis point share in mask (reticle) inspection**
- **700 bps share gain in overlay metrology and 100 bps share gain in thin film metrology**
- **Scale advantages and portfolio strategy that will keep KLA #1 in process control – using their dominance in pattern wafer inspection and mask (reticle) inspection as examples (these two businesses combined + services accounted for 40% of total CY19 sales)**
- **KLAC remains our top pick in semiconductor capital equipment 26**

KLA Accounts for Over 50% of a \$6.4B Semiconductor Process Control Market, > 4X Larger than Its Nearest Competitors

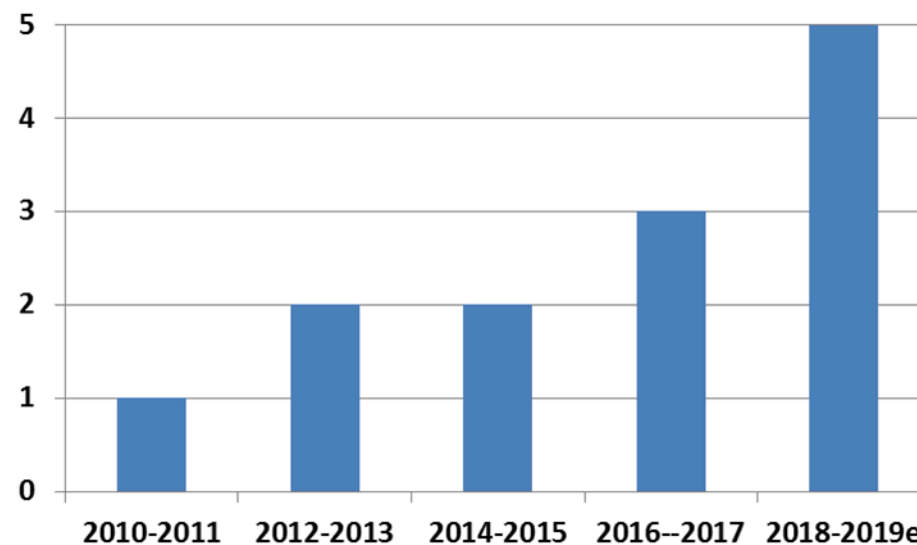
	Process Control	2015	2016	2017	2018	2019
1	KLA	2,043.2	2,406.0	2,816.6	3,263.8	3,347.1
	KLAC Share	48.3%	51.2%	51.3%	50.9%	53.6%
2	Applied Materials	492.9	579.7	651.4	734.9	706.6
	AMAT Share	11.7%	12.3%	11.9%	11.5%	11.3%
3	Hitachi High-Technologies	420.6	500.2	584.2	710.0	565.1
	HHT Share	9.9%	10.6%	10.6%	11.1%	9.1%
	Others	1,273.0	1,216.2	1,434.5	1,698.8	1,623.9
	Others Share	30.1%	25.9%	26.1%	26.5%	26.0%
	Total	4,229.7	4,702.1	5,486.7	6,407.5	6,242.7
	Total Share	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Gartner and J.P. Morgan; Note: Share may not add up to 100% due to rounding

- We expect KLA to grow core process control faster than the market on SAM and market share gains
- KLA-Tencor bringing innovative products to market
- Process control intensity is rising on increasing manufacturing complexity
- Should help KLA-Tencor build on its industry-leading financial model (>60% GM, >35% OPM, post-Orbotech transaction)

- KLA equipment revenues up 16% Y/Y, in line with WFE equipment growth (Source Gartner)
- Process control equipment revenues *grew* in 2019 (vs. WFE of down MSD) (Source J.P. estimates)
- Over 50% market share in process control equipment market
- >4X larger market share than its two nearest competitors

KLA-Tencor Product Platform Launches – 2010-2019



Source: Company reports

KLA: Diversified Leader in Advanced Silicon / Display / PCB Manufacturability

Through its acquisition of Orbotech, KLA has become a diversified leader in advanced silicon, display and PC manufacturability

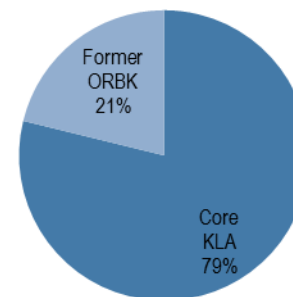
- KLAC is the leading supply of process control and manufacturability solutions for semiconductor, display and PCB markets
- **Diversified leader** with services accounting for ~25% of revenues and former Orbotech accounting for ~20% of revenues
- PCB and Display (large format and OLED) complexity increasingly driving the need for advanced inspection and repair – KLAC is the leader in inspection and report for both markets
- Former ORBK semiconductor segment exposed to advanced packaging, RF, power, MEMs that benefit from secular growth trends such as 5G, AI, autonomous driving, etc.
- **Best-in-class margin profile:** >60% GMs, >35% OPM and 28%-30% FCF margin
- **Strong capital returns** with dividend yield outpacing peers on strong cash generation – goal to return 70-75% to shareholders via dividend and share repurchases and we expect KLA to deliver on its \$2 billion share repurchase authorization over the next 6-8 quarters

Competitive Matrix of Key PCB, FPD and SD Segments

PCB Market					
	AOI (Automated Optical Inspection)	AOR/AOS (Automated Optical Repair, Shaping)	LDI (Laser Direct Imaging)	UV Drilling	Engineering
Installed base	#1	#1	#1	Planned for Flexible PCBs	#1
Market participants	<u>Orbotech</u> , CIMS (Camtek), DNS GigVis, Inspec <u>Machvision</u>	<u>Orbotech</u>	<u>Orbotech</u> , ORC Imaging, DNS, Ushio/Adtec, Hans Laser	<u>Orbotech</u> , Via Mechanics, Mitsubishi, Electro Scientific Industries	<u>Orbotech</u>
FPD Market					
	AOI (Automated Optical Inspection)	Test	Repair		
Installed base	#1	#1	Top 3		
Market Participants	<u>Orbotech</u> , ADP, LG, NCB Networks	<u>Orbotech</u> , Applied Materials, LG, Top Engineering	<u>Orbotech</u> , Charm Engineering Co., OMRON		
Specialty Semi					
	Advanced Packaging (Including Etch, PVD and CVD)	MEMS (Including Etch and PVD)		Power, RF, LED	
Market Participants	<u>Orbotech</u> , Lam Research, Applied Materials, AMEC, <u>Evatec</u>	<u>Orbotech</u> , Lam Research, MEMSTAR, <u>Evatec</u>		<u>Orbotech</u> , Applied Materials, <u>Evatec</u> , Advanced Modular Systems, <u>PlasmaTherm</u>	

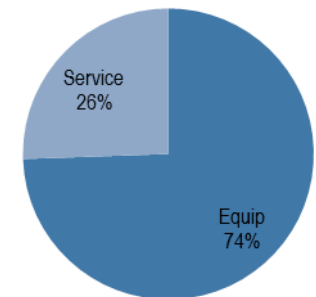
Source: Company reports and J.P. Morgan estimates.

CY20 Core KLA vs. Former ORBK



Source: J.P. Morgan estimates.

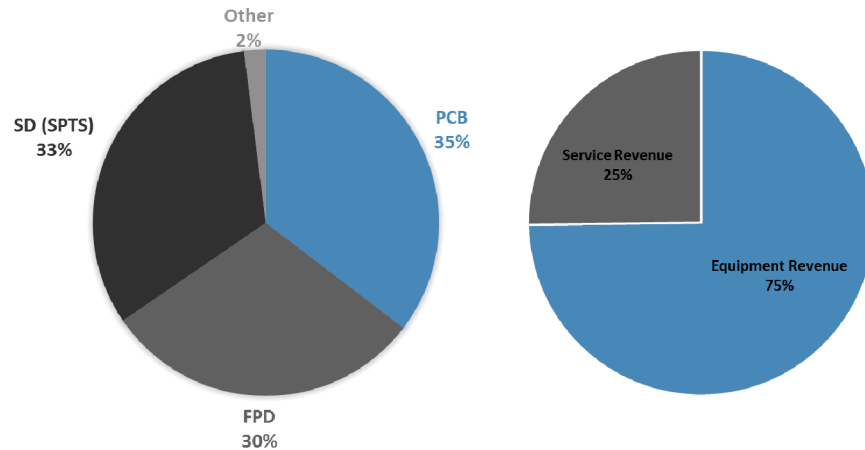
CY20 Rev - Equip vs. Service



Source: J.P. Morgan estimates.

Solid Product Cycles and SAM Expansion of Former Orbotech, Helping to Diversify KLA's End-Market, Customer Exposure

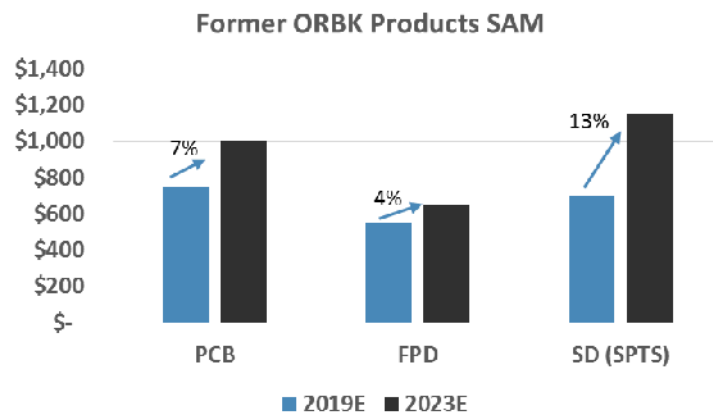
Former Orbotech End-Market Mix, Mix of Equipment vs. Service (2018)



Source: Company reports

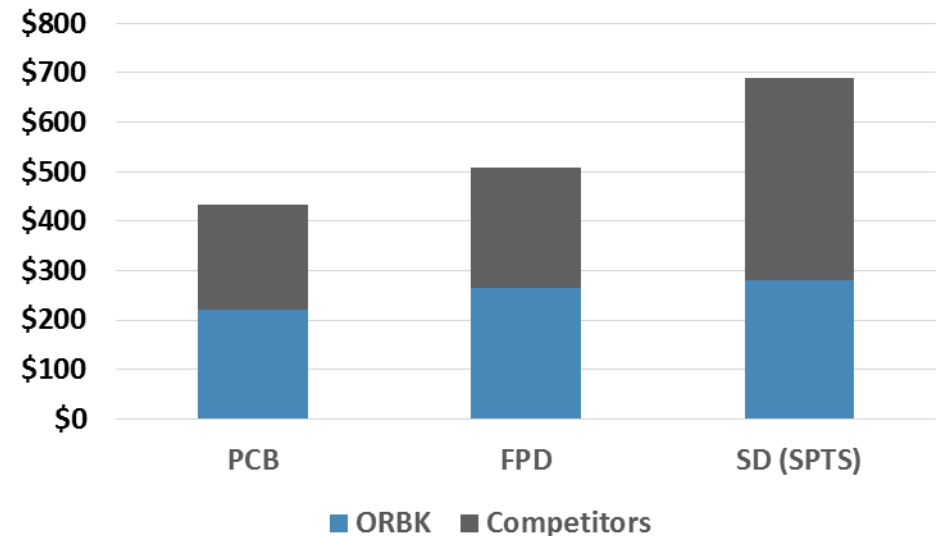
- ORBK revenues up 16% Y/Y in 2018 – strong growth in equipment and service
- Leadership positions in manufacturability solutions (inspection, repair) for PCB and FPD markets
- Strong position in specialty semi markets: Adv. Packaging, RF, Power, etc.
- Solid market share of served markets – ~50% share of PCB, FPD and ~40% of semiconductor served markets
- Served markets expanding at a 12% CAGR

TAM Expansion – PCB, FPD and Semiconductor – \$ Millions



Source: Company reports

Orbotech's 2018 Equipment Revenues vs. Estimated 2018 TAM*



Source: Company reports and J.P. Morgan estimates

* 2018 TAM calculated by applying expected growth rates per end-market (8% PCB, 13% FPD and 15% Semiconductor Devices)

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